

ANGELICA CREEK PARK RESTORATION PROJECT

Monitoring Report: Results of 2008 Monitoring Events

Angelica Creek Park, Reading, Berks County, Pennsylvania

Prepared for:

Public Works Department
City of Reading
503 North Sixth Street
Reading, Pennsylvania 19601

Prepared by:

A.D. Marble & Company
375 East Elm Street
Suite 200
Conshohocken, Pennsylvania 19428

February 2009

ABSTRACT

This report details the results of the first year of wetland and waterway monitoring of the Angelica Creek Park restoration project located in Reading, Berks County, Pennsylvania. Angelica Creek is a tributary to the Schuylkill River within the Upper Schuylkill River Basin. The project was created as a Supplemental Environmental Project (SEP) for the U.S. Environmental Protection Agency (USEPA) in order to mitigate for unauthorized discharges associated with the city's sewer treatment plant (USEPA Permit USAO# 2003V00437). As part of the USEPA-mandated consent decree with Reading, and as reflected in the Pennsylvania Department of Environmental Protection (PADEP) permit (PADEP E06-610), the site will be monitored for five years: twice in the first two years and once each year thereafter. Monitoring of the Angelica Creek Park restoration project was completed during the spring and fall of 2008. This report compiles the results of both monitoring assessments. Reading's Public Works Department will continue to maintain the site during and after the five-year monitoring period.

The project's purpose was to create an environmental education park that was open to the public and that would stabilize and restore Angelica Creek, create a range of naturalized habitats for aquatic and terrestrial wildlife, reestablish this segment of the creek as a cold water fishery (CWF), and provide access for recreation and observation of wildlife. In order to fulfill the project's purpose, A.D. Marble & Company provided a conceptual design that was adopted by the EPA as part of the SEP and incorporated into their goals for the Angelica Creek park. The goals were as follows:

- 1) Restore approximately 2,000 linear feet of Angelica Creek.
- 2) Restore aquatic habitat, restore and stabilize the streambanks utilizing bioengineering techniques (i.e., rock and log vanes, root wads), and restore floodplain habitat.
- 3) Develop a 100-foot riparian buffer from the pedestrian bridge to the S.R. 0010 underpass.
- 4) Construct two wetland areas of approximately 1 acre each.
- 5) Construct a 0.5-acre pond (open water habitat).
- 6) Develop 3 acres of upland meadow habitat around the wetland and riverine areas.

The site will be monitored for a total of five years post-construction. This report is intended to provide a baseline study of existing conditions following the first full growing season after construction.

As of the first year of monitoring (Spring and Fall 2008), this site has developed approximately 1.5 acres of vegetated emergent wetland, 0.6 acre of submerged/deep open water habitat, and 14.3 acres of meadow and riverine riparian habitat. The streambanks within the park area are stable, and rock and log vanes, as well as the root wads, are installed and appear to function as designed. In addition, the site contains a dense herbaceous cover throughout the park and 98 percent of the 100 planted trees have survived. The site is used as habitat by deer, small mammals, birds, and amphibians. The stream appears to be sustaining a macroinvertebrate population that is fairly diverse and fairly tolerant of pollution, which is typical of small streams in developed areas. Overall, the site meets the design and planned goals adopted by the EPA's SEP program to restore and enhance the park habitat while providing a variety of critical habitat. Future monitoring events will continue to evaluate the stream and wetland areas as well as document the success of planted species and the spread of invasive species.

TABLE OF CONTENTS

Abstract	<i>i</i>
Table of Contents	<i>iii</i>
List of Illustrations	<i>iv</i>

I. INTRODUCTION.....	1
A. Site and Project History	1
II. METHODS.....	5
A. Establishment of Sampling Location	5
B. Vegetation Sampling.....	6
C. Benthic Macroinvertebrate Sampling	8
D. Wetland Delineation	11
E. Stream Monitoring	11
F. Photograph Stations	11
III. RESULTS	12
A. Establishment of Vegetative Habitats	12
B. Woody Vegetation	17
C. Benthic Macroinvertebrate Population	18
D. Invasive Species.....	21
E. Local Fauna.....	22
F. Determination of Wetland Boundaries	23
G. Stream Restoration Measures	23
IV. CONCLUSIONS AND RECOMMENDATIONS.....	25
A. Design Elements of Angelica Creek Park Restoration Project.....	25
B. Recommendations for Future Site Management.....	29

References

Appendices

Appendix A: Quadrat Data and Summary
Appendix B: Composite Vegetation List by Habitat
Appendix C: Vegetation Seed Mixes by Habitat
Appendix D: Woody Plant Survivorship Data
Appendix E: Benthic Macroinvertebrate Survey
Appendix F: Site Monitoring Photographs
Appendix G: Supplemental Site Condition Photographs
Appendix H: 2008 Plan Sheets – Sampling Points, Wetland Delineations, and Planting Plans
Appendix I: Correspondence and Permit Documentation

LIST OF ILLUSTRATIONS

Figures

1.	Project Location Map.....	2
----	---------------------------	---

Tables

1.	Quadrats and Indicator Values in Designed Wetland Habitat, 2008	12
2.	Dominant Vegetation in Wetland 1 Quadrats	14
3.	Dominant Vegetation in Wetland 2 Quadrats	14
4.	Quadrats and Indicator Values in Designed Riverine Riparian Habitat, 2008	15
5.	Dominant Vegetation in the Riverine Riparian Zone	15
6.	Quadrats and Indicator Values in Designed Meadow Habitat, 2008	16
7.	Dominant Vegetation in Upland Meadow	16
8.	Planted Tree Survivorship by Species, 2008	17
9.	Taxa Identified by Kick Samples, April 2008	19
10.	EPT Taxa Richness, Riffles vs. Runs, April 2008	20
11.	PTI Results, Riffles vs. Runs, April 2008.....	20
12.	EPT Taxa and PTI Ratings for Snag Composite Sample, April 2008	20
13.	Invasive Species and Status, 2008	22
14.	Occupancy of Bat, Bluebird, and Wood Duck Boxes, 2008	22

I. INTRODUCTION

I. INTRODUCTION

The city of Reading, located in Berks County, Pennsylvania (Figure 1), completed the construction of a 12-acre environmental education park in the former location of Angelica Lake in the fall of 2007. This project was designed and constructed to restore the stream channel and floodplain and create wetlands within the former lakebed in order to develop unique ecological functions and values associated with the tributary to the Schuylkill River. In addition, pedestrian trails and crossings were created to encourage active and passive recreational opportunities for the local community.

A. Site and Project History

Before the Industrial Revolution, Angelica Creek flowed unimpeded through the mostly rural project setting. However, in the late 1800s, the Angelica Ice Company constructed an earthen dam along the creek to create Angelica Lake and facilitate ice production. In 1915, the city of Reading purchased the lake for public recreation, which included boating, fishing, and swimming. The city of Reading managed the lake for recreation until 2001 when Tropical Storm Alison dropped approximately 8 inches of rain in 24 hours, causing a dam breach and failure that drained the entire lake and damaged the S.R. 0010 bridge adjacent to the dam. The bridge was restored, but the dam was never reconstructed and the creek again flowed unimpeded into the Schuylkill River. Over time, Angelica Creek reestablished a meandering stream channel through the lake sediments, but the stream channel and floodplain remained in a degraded state due to poor bank stabilization, low habitat quality, and especially high sediment yields during storm events.

Reading's Public Works Department proposed to fund and construct a restoration project for this segment of Angelica Creek as part of a United States Environmental Protection Agency-mandated (USEPA-mandated) consent decree (USAO No. 2003V00437) (Appendix I). The project was part of a Supplemental Environmental Project (SEP) to mitigate for unauthorized discharges related to the city's sewer treatment plant. The restoration project would successfully stabilize the previously drained Angelica Lake basin in a way that would restore natural habitats and create public environmental education and recreational opportunities.

[illegible]

In order to fulfill the goals of the SEP, a conceptual design was solicited from A.D. Marble & Company for the park property. The conceptual design included 2,000 linear feet of stream restoration and stabilization, a 100-foot wide riparian buffer and floodplain zone, 0.5 acre of pond, 2 acres of palustrine emergent wetland, and 3 acres of upland meadow. In an effort to enhance the wildlife value of the park, the conceptual design also included wildlife habitat structures: bluebird boxes, wood duck boxes and perching structures, bat boxes, and in-stream structures for aquatic species. In addition, the site design provides for a walking trail, a new pedestrian bridge, a boardwalk through wetland habitat, and trail and educational signage.

Site construction and planting was completed in October 2007. The initial site monitoring was completed by A.D. Marble & Company in 2008. Subsequent monitoring and assessments for 2009 through 2012 will be completed by Albright College faculty and students with assistance from A.D. Marble & Company.

As designed, the site has five distinct vegetative communities: Wetland 1, Wetland 2, the pond, the riparian buffer, and the upland meadow. The five vegetative zones were planted and seeded with vegetation specific to the intended habitat. The plant stock and seed mixtures for each habitat are listed in Appendix C. A comprehensive list of all species identified within the project area, both planted/seeded and volunteer, is located in Appendix B. The plant sampling methodology is intended to record both planted and volunteer species present within the site. It should be noted that the pond was intended as an open water system and was planted only along the edge.

The five communities also rely on a variety of hydrologic inputs to maintain the intended biotic communities. Wetland 1 and Wetland 2 are both intended to receive event-related stormwater from the surrounding landscape and floodflow from the creek during significant storm events. Wetland 1 was designed to have multiple sources of hydrology, including stormwater runoff from the landscape, floodwater from Angelica Creek during significant flood events, and groundwater sources particularly closer to the pond. Approximately 100 feet downstream from the old pedestrian bridge, a diversion structure directs floodflow from the creek into the western end of the Wetland 1 basin. Subsurface and surface flow is intended to move from west to east

into the pond. The pond level is controlled by an outlet structure at the eastern end that discharges via a rock-lined swale into Angelica Creek, upstream from the new pedestrian bridge.

Wetland 2 also receives multiple sources of hydrology, including runoff from the adjacent hillside, seeps, and the occasional floodflow from Angelica Creek. Although Wetland 2 has no input structure, it discharges into Angelica Creek via a rock-lined swale downstream from the new pedestrian bridge.

The remaining vegetative zones within the project area are the riparian riverine zone and the upland meadow. The riparian riverine zone is intended to receive water from the creek during significant flood events. The upland meadow is intended to rely solely on direct precipitation. Both habitats are present on both sides of Angelica Creek.

This report documents site conditions during the first year of site monitoring. Discussion of the current conditions and success of created natural habitat is based on the successful establishment of vegetation appropriate for wetlands, riparian buffers, and upland meadows, as well as the presence and composition of the aquatic habitat. Specific information includes a benthic macroinvertebrate assessment, observations of wildlife and in-stream structures, wetland descriptions, percent vegetative cover and vegetative diversity assessments, woody plant survivorship, photographs, and maps documenting current conditions. Also included is an assessment of invasive species, including areas of greatest prevalence and a discussion of eradication techniques.

II. METHODS

II. METHODS

The site design called for the establishment of five separate vegetative zones:

- Wetland 1 (south of Angelica Creek)
- Wetland 2 (north of Angelica Creek)
- Pond (downgradient of Wetland 1)
- Upland Meadow (both sides of the waterway)
- Riparian buffer and floodplain (both sides of the waterway)

Field visits for sign installation and meetings were scheduled throughout 2008. Some observations were made during these visits to supplement scheduled data collection visits. The following field visits occurred during the first year following construction:

- Initial tree tagging and assessment: March 26, 2008
- Benthic macroinvertebrate sampling and wildlife observations: April 23, 2008
- Photographs and wildlife observations: May 22, June 7, June 27, July 23, July 28, and September 25, 2008
- Herbaceous and woody vegetation assessment, wildlife observations, and site photographs: August 13, 2008
- Wetland delineation and tree survivorship assessment: September 25, 2008
- Monitoring of in-stream bioengineering measures: March 26, May 22, June 7, June 27, July 23, July 28, September 25, and November 3, 2008

A. Establishment of Sampling Location

A linear sampling transect for each of the wetland habitats was established in 2008 based on the proposed wetland boundary and existing basins. Transect A passes through Wetland 1. Transect B passes through Wetland 2. Transect B also includes portions of the riverine riparian zone and upland meadow. The two transects were tracked by Global Positioning System (GPS) at approximately 100-foot intervals. One-inch diameter PVC posts were placed at approximately 300-foot intervals to minimize site disturbance. No posts were placed in the pond. Future site sampling methods may allow for sampling within the pond.

Sample plots were located at 100-foot intervals along each transect. Five sample plots were established along Transect A in Wetland 1. Nine sample plots were established along Transect B. See Appendix H, Plan Sheet 1 for the location of each sampling plot and transect.

At each sample plot location, a one-square-meter (10.8-sq. ft) sampling frame, or quadrat, was placed over the sample plot stake and to the right of the transect. The sampling quadrat, measuring two by 0.5 meter (6.6 by 1.6 ft), was oriented parallel to the baseline, with the stake touching the upper left corner of the frame. This ensured consistent sampling of the vegetation within the site.

B. Vegetation Sampling

1. Herbaceous Cover. When sampling vegetation within a given quadrat, each sampling plot will include a range of vegetative species with varying hydrological tolerances. The number of hydrophytic species versus non-hydrophytic species within a quadrat has a direct correlation to the level of hydrology available in and around that quadrat and to the development of wetland conditions at the site.

Herbaceous vegetation generally includes all vascular plants and woody plants under 24 inches in height. Both planted and volunteer herbaceous vegetation were sampled using visual estimates of percent aerial coverage within one-square-meter (10.8-sq. ft) quadrats. The dominant plant species were identified based on canopy coverage within each plot. Any plant species with less than five percent coverage were recorded as trace. Where applicable, estimated percents of standing water and bare earth were also recorded. Data for each quadrat are located in Appendix A. Although the project does not require a set permitted percent cover, a high percent of vegetative cover is beneficial to soil retention and stability.

To determine whether the vegetation sampled within each quadrat was hydrophytic, the Wentworth Index, based on a plant's indicator status, was used to obtain a weighted value for all plant species identified in the quadrat (Wentworth et al. 1988). The indicator value of each plant species was based on the wetland indicator status of plants from the *National List of Plant Species that Occur in Wetlands, Region 1 - Northeast* (Sabine 1993). The indicator values for the

plants range from wettest (OBL = 1.0) to driest (UPL = 5.0). In this way, a Wentworth value corresponds to the types of species present within a quadrat and their percent cover within that quadrat. Quadrats located in an area that is successfully developing wetland characteristics would be expected to have a Wentworth Value between 1.0 and 3.0. Quadrats located in an area that is developing upland characteristics would be expected to have a Wentworth Value greater than or equal to 3.0.

The weighted value for the plants was obtained by multiplying the percent cover of the plant species within the plot by the plant's indicator value and dividing by the total percent vegetative cover of the plot. By totaling the weighted values of each plant species, the Wentworth Index was determined. Any quadrat with a total indicator value less than or equal to 3.0 is considered to contain a dominance of hydrophytic vegetation. Any plant listed as NI (No Indicator) was automatically assigned an indicator value of 5.00. Open water, bare earth, and any plant species with trace cover were not included in the weighted value calculation.

Mean percent cover was then calculated for all the quadrats sampled within the constructed mitigation site. This was done by adding the visually estimated percent aerial coverage for each of the quadrats and dividing by the total number of quadrats sampled. Relative percent cover was then calculated and documented for the dominant species recorded. This value is a measure of the relative abundance of each of the dominant species within the mitigation site and allows for species composition changes to be tracked on the site for the duration of the monitoring period.

In addition to quadrat sampling, composite lists of herbaceous vegetation were compiled for each distinct habitat (Wetland 1, Wetland 2, Riparian/Floodplain, Upland Meadow, and Pond). These lists include both planted and volunteer species. These composite lists are included in Appendix B.

2. Survivorship of Woody Plants. According to the original landscape plans, nine species of trees and 13 species of shrubs were planted within the proposed meadow, riparian, and wetland zones. Five species of aquatic plants were planted within Wetlands 1 and 2, as well as along the pond border. Shrubs were not tagged in 2008. All planted trees were tagged in March

2008. Visual observations of planted trees and shrubs were made in March and August 2008. During the March 2008 tagging, several dead and stressed trees were observed and reported to the contractor, E. Kuser, Inc. The landscaping crew replaced these species during Summer 2008.

Initially, in March 2008, 97 trees were tagged to determine survivorship of the woody plant species on both an annual basis and, for future monitoring, over the five-year-monitoring period. Because of the dense clusters of shrub plantings, individual plants were not tagged; however, observations of general health were noted for each cluster of shrubs. These observations are included in this report. A few trees were not planted in the exact locations indicated on the plan sheets. Subsequent tagging during the August 2008 monitoring resulted in a total of 100 trees being tagged and assessed.

During the August 2008 monitoring, the condition of each tagged plant was noted and described as alive, stressed, dead, or missing. If tags were missing during the August field view, assumptions as to number were made based on nearby tagged specimens. Clusters of untagged shrubs were also noted and described accordingly.

Alive – Plant has a healthy amount of foliage, fruiting structures, and buds.

Stressed – Plant has discolored foliage or lacks foliage and fruiting structures.

Dead – No foliage or fruiting structures apparent on the entire plant; twig tips break off.

A listing and count of species tagged as well as a summary of the survivorship are included in the results section (Section III) of this report. A complete individual listing and health assessment of all tagged trees is located in Appendix C.

C. Benthic Macroinvertebrate Sampling

1. Field Sampling Procedures. Sampling of the macroinvertebrate community within Angelica Creek was performed in May 2008. Several sampling methods were used in order to represent the different physical habitats along the waterway. A modified version of the Project Heartbeat Volunteer Monitoring Handbook (Lathrop et al. 1994) and the Pennsylvania Pollution Tolerance Index (PTI) (Allegheny College 1998, modified from Barbour et al. 1997

and Mitchell and Stapp 1996) were used to obtain and analyze five traveling kick samples from three locations and one composite snag from five snag locations. To minimize disturbance, stream sampling was performed from downstream to upstream, starting at the southeastern section of Angelica Creek.

The traveling kick method of streambed sampling, as described in the PTI methodology, was used to sample the macroinvertebrate population within the project area. Traveling kicks (TK) were performed at three locations within the project area. Each traveling kick was performed for a length of approximately six feet, from upstream to downstream. Where possible, a separate sample was taken at riffles (F) and runs (R) at each location. A one-meter-by-one-meter kick net was used at each traveling kick location. In accordance with the traveling kick procedure, large macroinvertebrates, such as mature crayfish or adult dragonflies, and any vertebrates (fish, frogs, tadpoles, etc.) captured in the sample were noted but removed from the final sample. Samples including substrate were then placed in jars and preserved with a 70 percent ethanol solution for laboratory analysis. Each sample was labeled with the location number and the type of sampling performed. For example, a traveling kick sample taken in a riffle at location #1 was labeled “TK-1-F”; a kick sample taken in a run at location #2 was labeled “TK-2-R.”

In addition to the traveling kick, the five installed snags within the creek were sampled using a D-net to capture macroinvertebrates. These snags were made from logs placed into the streambed and banks, providing cover and woody substrate. These snags were usually located near runs and pools and effectively trapped leaf litter and other debris commonly used by macroinvertebrates for food and cover. Due to the low volume of the snag samples compared to the traveling kick samples, a single composite sample of the five snags was preserved for lab analysis. This sample was labeled as “Snag-Composite.”

Any calculations based on identified macroinvertebrates are affected by the number of organisms gathered. Overall, kick samples taken in runs are expected to support less macroinvertebrates than riffles due to deeper, slower waters and differences in substrate and oxygen levels that affect the types of organisms present. Snag samples, which include organisms that utilize decaying wood and leaf litter, are also expected to result in different taxa than either riffle or run samples.

Composite samples combining riffles and runs are valid for showing population trends along the waterway but should not be directly compared to either individual kick samples or the snag composite sample. Composite samples are included in Appendix E. Section III.C discusses individual kick samples and the snag composite sample.

2. Laboratory Assessment and Calculations. A 10-inch-by-10-inch grid was used to identify each sample, divided into a 25-square grid, and labeled from A to E on the X-axis and 1 to 5 on the Y-axis. Due to the limited sample size and low numbers of individual macroinvertebrates observed, it was decided that the entire sample would be examined and identified rather than using a 10 percent subsample.

For each square of the grid, the substrate was examined using tweezers, hand lenses, and a stereoscope to remove and identify any observed macroinvertebrates. Individuals that could not be identified were noted as “Unknown.” Where applicable, descriptive notations were made to differentiate between different sub-groups of organisms.

After identification of the entire sample, each sample was placed back into a jar with additional 70 percent ethanol for preservation. For comparison purposes only, the data was combined for sampling locations with both riffles and runs, and the same metrics were calculated for the composite samples. The physical samples remained separate and distinct.

Metrics used to assess the benthic macroinvertebrate community included Ephemeroptera-Plecoptera-Trichoptera (EPT) taxa and percentages, total taxa richness, and two Pollution Tolerance Indices. For comparative purposes, two separate Pollution Tolerance Indices were used to qualitatively assess the stream: the Hoosier Riverwatch PTI, hereon referred to as the Riverwatch PTI (Hoosier Riverwatch March 2005, accessed October 2, 2008), and the PTI currently used by all Pennsylvania volunteer stream monitoring groups and the PADEP, referred to as the Pennsylvania PTI (Allegheny College 1998, accessed October 2, 2008). Additional information on the metrics used is available in Appendix D. Other metrics or indices may be used in subsequent monitoring.

Additional qualitative observations of aquatic organisms, including vertebrate species, were made in May and August 2008. These observations are included in Section III.

D. Wetland Delineation

A wetland delineation was performed in September 2008 using modified criteria based on the procedures outlined in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). The wetland delineation was based primarily on the presence of hydrophytic vegetation and hydrology as hydric soils have not fully developed. The wetland limits were mapped using a Trimble GPS unit.

E. Stream Monitoring

In addition to sampling the aquatic biotic community, the stability of the streambanks and the condition of the bioengineering measures were monitored. During each site visit, photographs were taken and a visual survey was performed to determine if erosion or instability of the streambanks has occurred. In addition, the condition of in-stream structures, such as rock and log vanes and root wads, were observed to determine if these features remained intact and whether the desired aquatic habitat (i.e., pools, riffles) was created. Photographs of each vane and snag were taken, as well as of the entire stream corridor, and will serve to evaluate their effectiveness in subsequent years. These photographs are located in Appendix G (Photographs R to W).

F. Photograph Stations

Eleven photograph locations were chosen to document conditions throughout the monitoring process. Photographs at each location taken during the 2008 monitoring season are included in Appendix F. The locations and directions of these photograph stations are shown on Plan Sheet 1 in Appendix H. Additional representative photographs of the entire site have been provided in Appendix G to show existing on-site conditions over the first growing season.

III. RESULTS

III. RESULTS

The basins of Wetland 1 and Wetland 2 were designed to be wetland habitat. Riverine riparian areas were to be located on both floodplains of Angelica Creek. The remaining lands were designed to be meadow habitat. The results of the 2008 delineation indicate that 1.5 acres of palustrine emergent wetland and 0.6 acre of submerged/open water habitat have been created at the site. Wetland 1 has developed approximately 0.4 acre of palustrine emergent wetland habitat. Wetland 2 has developed approximately 1.1 acres of palustrine emergent wetland habitat. These areas are shown in Appendix H, Plan Sheet 2.

A. Establishment of Vegetative Habitats

1. **Wetland Habitat – Wetland 1 and Wetland 2.** Transect A starts at the edge of the Wetland 1 basin and ends at the upland boundary between the open water area and the trail parallel to Angelica Creek. Three of the four Transect A plots are within Wetland 1. A section of the transect fell within the open water pond; no plots were able to be placed within the pond. Transect B starts at the meadow and upland slopes along S.R. 0010 and extends across Wetland 2 to the riparian riverine zone and the upland meadow. Four of the eight Transect B plots are within Wetland 2.

Table 1 shows the Wentworth Indicators for the eight plots associated with Wetland 1 and Wetland 2 for the first monitoring event. Six of the eight plots had a dominance of wetland vegetation, as indicated by a Wentworth Index value less than 3.0. A detailed list of recorded vegetation and indicators in each quadrat is located in Appendix A. Composite vegetation lists for each wetland are located in Appendix B.

Table 1. Quadrats and Indicator Values in Designed Wetland Habitat, 2008.

Quadrat	Designed Habitat	Weighted Wentworth Indicator Values - 2008
A+000	Wetland 1	2.17
A+100	Wetland 1	2.95
A+200	Wetland 1	3.32
A+300	Wetland 1	1.97
B+100	Wetland 2	2.15
B+200	Wetland 2	1.80
B+300	Wetland 2	1.45
B+400	Wetland 2	3.43

Both the vegetation within the quadrats and composite lists of vegetation within Wetlands 1 and 2 indicate that planted and seeded species, as well as volunteer species from the surrounding landscape, are growing within the basin. Of the 39 herbaceous plant species identified within Wetland 1 in 2008, 16 are volunteer species. Four of these are known to be invasive: *Humulus japonicus* (Japanese hops), *Lythrum salicaria* (purple loosestrife), *Robinia pseudoacacia* (black locust), and *Persicaria perfoliata* (mile-a-minute or Asiatic tearthumb). Of the 42 species identified within Wetland 2 in 2008, 18 are volunteer species. Five of these are known invasive species: Japanese hops, purple loosestrife, black locust, mile-a-minute, and *Phalaris arundinacea* (reed canarygrass). Of the five species located within the wetland areas, purple loosestrife and mile-a-minute are listed as Pennsylvania Noxious Weeds.

As noted during the 2008 monitoring event, there are differences in the average Wentworth Indicator value between the two wetlands. Although the overall vegetative composition is similar between the basins, Wetland 1 had an average indicator value of 2.6, while Wetland 2 had an average indicator value of 1.8. This disparity can best be explained by the hydrological differences between the two wetland areas. Wetland 1 had no standing water with the exception of the adjacent pond, and upland vegetation was present and dominant in portions of the site. Wetland 2 had pockets of standing water throughout the wetland and was dominated entirely by hydrophytic vegetation.

The two wetlands also show differences in dominant species identified within the quadrats. Dominant species are those that comprise 20 percent cover or more of a given quadrat. Wetland 1 had nine species that were dominant in at least one quadrat (Table 1); the indicator value of these species ranged from OBL (1.0) to FACU- (4.33). The only species dominant in more than one quadrat were facultative species (3.0). This indicates that a significant section of Wetland 1, centered around section A+200, may not develop wetland characteristics without changes in hydrology.

Four volunteer species were dominant in Wetland 1 quadrats: one is an upland species and three are hydrophytic species (Table 2). As previously noted, one of these hydrophytes, purple loosestrife, is an invasive species and a Pennsylvania Noxious Weed. Purple loosestrife was also

noted throughout the park. See Section III.D for additional information about invasive species within the project area.

Table 2. Dominant Vegetation in Wetland 1 Quadrats.

Common Name	Scientific Name	Indicator Value	Location	Volunteer Species? (Yes/No)
tussock sedge	<i>Carex stricta</i>	OBL	A+300	Yes
yellow nutsedge	<i>Cyperus esculentus</i>	FACW	A+300	Yes
soft rush	<i>Juncus effusus</i>	FACW+	A+000	No
slender rush	<i>Juncus tenuis</i>	FAC-	A+300	No
purple loosestrife	<i>Lythrum salicaria</i>	FACW+	A+300	Yes*
switchgrass	<i>Panicum virgatum</i>	FAC	A+000, A+100, A+200	No
fowl bluegrass	<i>Poa palustris</i>	FAC	A+000, A+100, A+200	No
white clover	<i>Trifolium repens</i>	FACU-	A+200	Yes
blue vervain	<i>Verbena hastata</i>	FACW+	A+000	No

* Volunteer and Invasive Species

In Wetland 2, eight species were dominant in the quadrats. Of these eight, five species were dominant in more than one quadrat; the indicator value of these species ranged from OBL to FACW (2.0) (Table 3). Two of these, purple loosestrife and reed canary grass, are volunteer species but are also considered invasive species. See Section III.D for additional information about invasive species within the project area.

Table 3. Dominant Vegetation in Wetland 2 Quadrats.

Common Name	Scientific Name	Indicator Value	Location	Volunteer Species? (Yes/No)
devil's beggarstick	<i>Bidens frondosa</i>	FACW	B+200	No
rough barnyard grass	<i>Echinochloa crusgalli</i>	FACW+	B+200	No
purple loosestrife	<i>Lythrum salicaria</i>	FACW+	B+100, B+300	Yes*
reed canarygrass	<i>Phalaris arundinacea</i>	FACW+	B+100	Yes*
Pennsylvania smartweed	<i>Polygonum pennsylvanicum</i>	FACW	B+400	Yes
black eyed Susan	<i>Rudbeckia hirta</i>	FACU-	B+400	No
curly dock	<i>Rumex crispus</i>	FACU	B+400	No
dark green bulrush	<i>Scirpus atrovirens</i>	OBL	B+300	No

* Volunteer and Invasive Species

2. Riparian Riverine Zone. The riparian riverine zone extends parallel to the streambanks of Angelica Creek and is intended to be an active floodplain with a mix of hydrophytic and upland vegetation. A significant number of planted woody vegetation (trees and shrubs) are located in this zone. Two of the quadrats along Transect B are located in the riparian zone.

Table 4 lists the Wentworth Indicators for these plots in 2008. Riverine areas were planted with a mix of hydrophytic and upland vegetation and, therefore, cannot be distinguished by their indicator value. However, the riverine area is intended to be part of the Angelica Creek floodplain and, as such, should be inundated fairly frequently during storm events. For this reason, it is likely that a functioning riparian zone would be closer to the middle of the indicator value range, with neither obligate species (1.0) or upland species (5.0) as dominant within a given quadrat. Both of the riparian plots have a Wentworth Index value of greater than 3.0. B+500 appears to have a greater mix of hydrophytic and upland species than B+400, possibly due to proximity to Angelica Creek. A detailed list of recorded vegetation and indicators in each quadrat is located in Appendix A; a composite vegetation list for the riparian riverine zone is located in Appendix B.

Table 4. Quadrats and Indicator Values in Designed Riverine Riparian Habitat, 2008.

Quadrat	Designed Habitat	Weighted Wentworth Indicator Value - 2008
B+500	Riverine	3.20
B+600	Riverine	1.89

In the riparian quadrats, four species were dominant one of which, black-eyed Susan, was dominant in both quadrats (Table 5). Two volunteer and invasive species, purple loosestrife and reed canary grass, were dominant in both quadrats.

Table 5. Dominant Vegetation in the Riverine Riparian Zone.

Common Name	Scientific Name	Indicator Value	Location	Volunteer Species? (Yes/No)
purple loosestrife	<i>Lythrum salicaria</i>	FACW+	B+600	Yes*
reed canarygrass	<i>Phalaris arundinacea</i>	FACW+	B+600	Yes*
black eyed Susan	<i>Rudbeckia hirta</i>	FACU-	B+500	No
Canadian horsetweed	<i>Conyza canadensis</i>	UPL	B+500	No

* Volunteer and Invasive Species

3. Upland Meadow. The meadow areas are located along the slopes of Angelica Creek, as well as between the wetland and the hillside in the northern and northwestern portions of the site. The meadow is intended to provide habitat and cover for many avian and insect species using the site and includes wildflower mixes and planted deciduous trees. One quadrat along Transect A and three quadrants along Transect B are located in the meadow zone. A detailed list of recorded vegetation and indicators in each quadrat is located in Appendix A; a composite vegetation list for the meadow zone is located in Appendix B.

Table 6 shows the Wentworth Indicators for these plots in 2008. All of the riparian plots have a Wentworth Index value of greater than 3.0.

Table 6. Quadrats and Indicator Values in Designed Meadow Habitat, 2008.

Quadrat	Designed Habitat	Weighted Wentworth Indicator Value - 2008
A+END	Meadow	3.52
B+000	Meadow	3.60
B+700	Meadow	3.67
B+800	Meadow	3.10

In the meadow areas, four species were dominant, two of which, black-eyed Susan and plains coreopsis, were dominant in multiple quadrats (Table 7). Three of the four species were seeded species. Although no listed invasive species were dominant in the meadow quadrats, invasive species were noted within the meadow habitat. See Section III.D and the Maintenance Plan for information on eradicating invasive species.

Table 7. Dominant Vegetation in Upland Meadow.

Common Name	Scientific Name	Indicator Value	Location	Volunteer Species? (Yes/No)
evening primrose	<i>Oenothera biennis</i>	FACU-	A+END	Yes
black eyed Susan	<i>Rudbeckia hirta</i>	FACU-	A+END, B+700, B+800	No
plains coreopsis	<i>Coreopsis tinctoria</i>	FAC-	B+000, B+700	No
chicory	<i>Chicorium intybus</i>	NL	B+800	No

B. Woody Vegetation

Survivorship of the tagged woody plants was evaluated in March and August 2008 to determine the percent survivorship in the first growing seasons (Appendix D). To evaluate woody survivorship at the site, every planted tree that was shown in the planting plan was tagged, flagged, and recorded in 2008. Shrubs were not tagged but were observed for general health due to the density of the planting clusters. The woody vegetation was observed to have a 95 percent survival rate (alive and stressed) of planted individuals in the first growing season. Five individual trees observed to be dead in March 2008 were replaced within the site boundaries during the summer (2008).

During the August 2008 survey, five redbud trees that did not appear on the planting plan were observed along the southern banks of Angelica Creek. It was assumed that these trees were planted sometime after March as a replacement for the five dead trees. The five replacement trees were all redbuds; four of these trees showed signs of stress including top dieback and dead leaves. Of the 100 trees tagged, six were observed to have signs of stress including dieback along the top and sides and wilted, brown leaves. Table 8 summarizes the survivorship of planted trees at the site, by species and health level.

Table 8. Planted Tree Survivorship by Species, 2008.

<i>Scientific Name</i>	Common Name	Plan Sheet 3 Abbreviation	Number Planted at Site	2008 Tree Survey			
				Alive and Thriving (A)	Alive and Stressed (S)	Dead (D)	Missing (M)
<i>Acer saccharinum</i>	silver maple	AS	13	12 (92%)	1 (8%)	0 (0%)	0 (0%)
<i>Betula nigra</i>	river birch	BN	20	19 (95%)	0 (0%)	0 (0%)	1 (5%)
<i>Carpinus caroliniana</i>	ironwood	CC	8	5 (63%)	3 (37%)	0 (0%)	0 (0%)
<i>Fraxinus pennsylvanica</i>	green ash	FP	2	2 (100%)	0 (0%)	0 (0%)	0 (0%)
<i>Liriodendron tulipifera</i>	tulip poplar	LT	3	3 (100%)	0 (0%)	0 (0%)	0 (0%)
<i>Platanus occidentalis</i>	American sycamore	PO	10	10 (100%)	0 (0%)	0 (0%)	0 (0%)
<i>Pinus strobus</i>	white pine	PS	16	14 (88%)	1 (6%)	0 (0%)	1 (6%)
<i>Quercus palustris</i>	pin oak	QP	2	2 (100%)	0 (0%)	0 (0%)	0 (0%)
<i>Quercus rubra</i>	red oak	QR	26	25 (96%)	1 (4%)	0 (0%)	0 (0%)
TOTAL PLANTED TREES			100	92 (92%)	6 (6%)	0 (0%)	2 (2%)

Shrub clusters observed along the riparian riverine zone were overall in very good health with the exception of two *Cornus racemosa* (red-osier dogwood) clusters located on the southern banks of the creek and near the new pedestrian bridge. One cluster of plants showed either signs of accidental cutting by machinery (weed whackers, etc) as part of the trail maintenance, deer browse, or a combination of these two factors. Other individuals within the cluster, farther from the trail, were alive and thriving. A second cluster of red-osier dogwoods appeared to be negatively impacted by gravel and dirt that is eroding from the unpaved construction access road along the hillside. The shrubs in this area show signs of stress including brown leaves and bare branches. The gravel washout may be smothering these plants.

Overall, the planted individuals, both shrubs and trees, appear to be healthy and thriving. Several shrubs were observed with berry clusters during the August 2008 survey. One invasive woody species, black locust, is present throughout the site. As the site develops, it is anticipated that additional volunteer woody species will colonize at the site.

A complete individual listing of tagged woody plants and survivorship results is located in Appendix D.

C. Benthic Macroinvertebrate Population

Five traveling kick samples were taken at three locations along Angelica Creek in April 2008. One composite sample of five snags was also taken at this time. Site 1 is located downstream of the new pedestrian bridge, in the southwestern quadrant of the site. Two kick samples were taken at a riffle (TK-1-F) and at a run (TK-1-R). Site 2 is located towards the center of the site, in a straight section of Angelica Creek. Two kick samples were taken at a riffle (TK-2-F) and at a run (TK-2-R). Site 3 is located upstream of the old pedestrian bridge, at the eastern edge of the park. One kick sample was taken at a riffle (TK-3-F). See Appendix G for detailed information of species located in each sample and taxa calculations. See Appendix G for the location of all traveling kick sites and snags.

Twenty-five taxa were identified in the six macroinvertebrate samples (Table 9). Some of these taxa may represent different life stages in the same type of organism (larva vs. adult); according

to the PTI protocol, these can be assumed to be separate species. When possible, these differences were noted to reflect observations of physical characteristics (brown caddisflies vs. green caddisflies). The Pollution Tolerance Indices used in 2008 do not require identification to the order, genus, or species level and are based on visual identification to family level only.

Table 9. Taxa Identified by Kick Samples, April 2008.

Macroinvertebrate	Location Found
Alderfly larva	TK-1-F, TK-1-R, TK-3-F, Snag
Amphipod	TK-2-R
Aquatic Earthworm	TK-2-F, TK-2-R, TK-3-F
Black fly larva	TK-2-F, TK-2-R
Caddisfly	TK-2-F, TK-2-R
Caddisfly larva	TK-1-F, TK-1-R, TK-3-F, Snag
Caddisfly larva-green	TK-1-F, TK-2-F, TK-2-R, TK-3-F, Snag
Crane fly larva	TK-3-F
Crayfish	TK-1-R, TK-2-R, TK-3-F
Damselfly larva	Snag
Damselfly nymph	TK-2-F, Snag
Dragonfly nymph	TK-3-F
Fingernail clam	TK-1-F, Snag
Gilled snail	Snag
Horsefly larva	TK-3-F
Leech	TK-2-F, TK-2-R, TK-3-F
Mayfly larva	TK-1-F
Mayfly nymph	TK-1-F, TK-3-F, Snag
Midge Larva	TK-1-F, TK-1-R, TK-2-F, TK-2-R, TK-3-F, Snag
Moth pupa	TK-2-F
Rat-tailed midge	TK-1-F, TK-1-R, TK-2-F, TK-3-F
Stonefly adult	TK-2-F
Stonefly larva	TK-2-F
Stonefly nymph	TK-1-F, TK-2-R
Waterpenny	TK-1-F, TK-1-R, TK-2-F
Unknown	TK-1-F, TK-2-R, TK-3-F, Snag

Table 10 compares the calculated taxa richness in traveling kick samples taken in riffles and runs. As expected, riffles tend to have both a higher overall organism count and a higher diversity of EPT species. This can be attributed to the physical characteristics of riffles, which are generally higher in dissolved oxygen than runs and have a shallow rocky substrate that attracts a wider variety of organisms, especially shredders, filter feeders, and predators. As seen in Table 11, all the riffle samples had a PA PTI rating of Fair. Of the two run samples, one had a PTI rating of Fair, and the other was rated as Poor.

Table 10. EPT Taxa Richness, Riffles vs. Runs, April 2008.

Macroinvertebrate Sample	Type of Habitat	No. Individuals in Sample	Taxa Richness (# Taxa)	EPT Taxa (SUM EPT Taxa)	Sum EPT Organisms	%EPT (Sum EPT Organisms/Total # Organisms)
TK-1-F	Riffle	121	8	5	89	73%
TK-2-F	Riffle	88	12	4	38	43%
TK-3-F	Riffle	64	12	3	34	53%
TK-1-R	Run	40	6	1	3	8%
TK-2-R	Run	27	9	3	12	44%

Table 11. PTI Results, Riffles vs. Runs, April 2008.

Macroinvertebrate Sample	Type of Habitat	Riverwatch PTI Value	Riverwatch PTI Rating	PA PTI Value	PA PTI Rating
TK-1-F	Riffle	22	Good	29.9	Fair
TK-2-F	Riffle	23	Excellent	23.5	Fair
TK-3-F	Riffle	23	Excellent	27	Fair
TK-1-R	Run	15	Fair	15.5	Poor
TK-2-R	Run	21	Good	21.8	Fair

The composite snag sample was taken from the five snags located along Angelica Creek. Generally, snags are distinct habitats that will support a different range of species than the silt-cobble-boulder streambed. The snags were composed of wood logs embedded into the streambank and placed at angles to the water flow, with trapped leaves and sediment located towards the side and top of the snag structure. As expected, the composite snag sample had a few species not observed in other samples, such as a damselfly larva and a gilled snail. A summary of calculated macroinvertebrate statistics for the snag sample is in Table 12.

Table 12. EPT Taxa and PTI Ratings for Snag Composite Sample, April 2008.

No. Individuals in Sample	52
Taxa Richness (# Taxa)	9
EPT Taxa (SUM EPT Taxa)	3
Sum EPT Organisms	31
Percent EPT (Sum EPT Organisms/Total # Organisms)	60%
Riverwatch PTI Value	20
Riverwatch PTI Rating	Good
PA PTI Value	26
PA PTI Rating	Fair

Overall, the traveling kick and snag samples show that the general taxa diversity, EPT diversity, and Pollution Tolerance Ratings for this segment of Angelica Creek fall in the “Fair” range and are consistent throughout the project area. This is to be expected given the history of the site and level of disturbance during the first year after construction. Additional annual monitoring could

show whether this segment of Angelica Creek continues to support a diverse macroinvertebrate population that supports fish, amphibians, and other vertebrates common to warm water fisheries in Pennsylvania.

D. Invasive Species

Prior to the August 2008 field survey, five invasive species were identified within the Angelica Creek project area. These species are already considered to be noxious and/or invasive weeds on national or state lists. Invasive species can be native or non-native and tend to out-compete other vegetation for space and nutrients or strangle or stunt existing vegetation. Invasive species also can limit access and aesthetic enjoyment of the park. As agreed upon by the city of Reading, the Reading Public Works Department, Utilities Division's Wastewater Team will be the primary agency maintaining the grounds and eliminating invasive vegetation. A maintenance plan is being developed by A.D. Marble & Company to deal with existing on-site invasive species.

Invasive species identified prior to the August 2008 survey were *Phragmites australis* (common reed), black locust, purple loosestrife, mile-a-minute, and Japanese hops. Of these five, all were observed during the August 2008 survey and one, purple loosestrife, was recorded in several quadrats, indicating a significant presence within the site. During the August 2008 survey, reed canary grass and *Polygonum pensylvanicum* (Pennsylvania smartweed) were also identified as invasive species present at the site.

Table 13 lists invasive species, status, and its general location within the Angelica Creek project area. A noxious weed is a plant species that has been determined to be a major pest of agricultural ecosystems and are subject, by law, to certain restrictions on a state or federal level (Plant Conservation Alliance-Alien Plant Working Group 2008). This means that it is illegal to grow, sell, or transport a species within a given state or throughout the country. Listing as an invasive species (I) indicates that while the species is not native and has the potential to do harm, the growth, sale, and distribution of the species is not illegal. However, the propagation of these species is not to be encouraged.

Table 13. Invasive Species and Status, 2008.

Common Name	Scientific Name	Weed Status (PANW, USNW, USW, I)*	Present in Composite List(s)? (Y/N)	Present in Quadrat(s)? (Y/N)
Japanese hops	<i>Humulus japonicus</i>	I	Y	N
purple loosestrife	<i>Lythrum salicaria</i>	PANW	Y	Y
mile-a-minute /Asiatic tearthumb	<i>Persicaria perfoliatum</i>	PANW	Y	N
reed canary grass	<i>Phalaris arundinacea</i>	I	Y	Y
common reed	<i>Phragmites australis</i>	I	Y	N
Pennsylvania smartweed	<i>Polygonum pensylvanicum</i>	I	Y	Y
black locust	<i>Robinia pseudoacacia</i>	I	Y	N

Source: Plant Conservation Alliance-Alien Plant Working Group, 2008.

*PANW - Pennsylvania State-Listed Noxious Weed; USNW - U.S. Noxious Weed; USW - U.S. Weed; I - Invasive or weedy species according to Uva, R.H., J.C. Neal, & J.M. DiTomaso. Weeds of the Northeast. Cornell University Press, Ithaca, New York, as noted in the USDA Plants Database,

E. Local Fauna

In March 2008, five bluebird boxes, three wood duck boxes, and two bat boxes were installed at the site in appropriate onsite habitats to support various local fauna. The boxes were inspected in May 2008 and August 2008 to determine whether the boxes were being used and, if so, by which species. Table 14 lists the findings based on field observations.

Table 14. Occupancy of Bat, Bluebird, and Wood Duck Boxes, 2008.

Box Type	Identification	Species & Date Observed
Bat	B1	N/A
Bat	B2	N/A
Bluebird	BB1	swallows: April 2008
Bluebird	BB2	swallows: April 2008
Bluebird	BB3	swallows: April 2008
Bluebird	BB4	swallows: April 2008
Bluebird	BB5	swallows: April 2008
Wood Duck	WD1	starlings: April 2008.
Wood Duck	WD2	starlings: April 2008.
Wood Duck	WD3	starlings: April 2008.

Other signs or direct observations of birds, mammals, and amphibians were noted at the site. In the wetlands and pond areas, bullfrogs were heard, and a great blue heron was observed in the deep water habitat of Wetland 1. Although no bluebirds were observed nesting in the boxes during the April or August field views, bluebirds were present in the meadow habitat of the site in August 2008. Also observed were swallows, red-winged blackbirds, goldfinches, starlings, red-tailed hawks, belted kingfishers, and turkey vultures. Deer browse, scat, and bedding areas

were noted throughout the site. A groundhog was observed in July 2008 during the official opening of the site, and visitors have reported a red fox in and around the site. A green heron was also observed at the site in the summer of 2008.

The presence of predators, prey, and scavengers observed at the site indicates that the habitat is diverse enough to support a range of species. As the site develops, more native fauna will likely utilize Angelica Creek for its food, shelter, and breeding resources.

F. Determination of Wetland Boundaries

A wetland delineation was performed in September 2008 using modified criteria based on the procedures outlined in the *U.S. Army Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). Since the site was recently built, hydric soils have not fully developed. However, areas of the site are clearly functioning as wetlands. Therefore, the wetland delineation was based primarily on the presence of hydrophytic vegetation and hydrology. Over time, it is likely that hydric soils will develop in the areas designed as wetland habitat.

The wetland limits were mapped using a Trimble GPS (Appendix H, Plan Sheet 2). In the areas designed as Wetland 1, approximately 0.4 acre of palustrine emergent wetland habitat was delineated in 2008. This excludes the pond, which was delineated as approximately 0.6 acre of palustrine open water/submerged habitat. As previously noted, the center of Wetland 1 does not support wetland habitat at this time, but would be categorized as transitional area due to the mixture of upland and wetland species. In the area designated as Wetland 2 and the surrounding meadow and riverine riparian sections, 1.1 acres of palustrine emergent wetland habitat were delineated. A section of the upland meadow area receives water from a stormwater swale allowing hydrophytic vegetation to dominate along the fringes of the swale.

G. Stream Restoration Measures

Visual survey of the streambanks and bioengineering measures occurred during the majority of site visits. Photographs of the stream corridor and banks, as well as bioengineering measures, are located in Appendix G. During these surveys, the streambanks appeared stable and fully vegetated with herbaceous vegetation and shrubs. In addition, all rock and log vanes and root wads were intact and pools have developed downstream of these features. Attention should be

paid to Rock Cross Vane #3, which may have been installed slightly higher than desired and may become an impediment to fish passage (Appendix F, Photograph 8). Finally, site visits revealed that the maintenance crew has been clearing debris from the diversion inlet and pond outlet structures following storm events. The continuation of these maintenance practices will be essential for the development of Wetland 1 and management of the pond habitat.

IV. CONCLUSIONS AND RECOMMENDATIONS

IV. CONCLUSIONS AND RECOMMENDATIONS

The purpose of the Angelica Creek Park Restoration Project was to develop an environmental education and recreation park through the restoration and enhancement of a degraded channel of Angelica Creek within the drained Angelica Lake basin. The project was intended to create a mix of wetland, open water, riverine riparian floodplain, and upland meadow habitats along the 100-year floodplain. The site design also incorporated flood and stormwater control and sediment/nutrient filtration functions within the floodplain.

As noted previously, this project was developed as an SEP with the USEPA, in coordination with PADEP and United States Army Corps of Engineers (USACE). Both the USEPA and PADEP permits require a five-year annual monitoring and maintenance effort. The PADEP permit also requires biannual (every six months) monitoring of the site for the first two years, followed by annual monitoring for the remaining three years. In addition, woody vegetation that does not survive this time period is to be replaced. All permit documentation is in Appendix I.

A.D. Marble & Company delineated the site in 2008 to determine if the intended acreage of wetland, open pond, and riparian and upland meadow habitat had been created. This study was intended to serve as a baseline for future studies to be completed by Albright College for the next four years, with assistance from A.D. Marble & Company. The site was monitored to assess the development of vegetative cover, survivorship of woody plantings, presence of invasive species, wildlife usage, and the quality of restored stream habitat. The results of the initial 2008 monitoring indicate that the site overall has been successful in meeting its objectives.

A. Design Elements of Angelica Creek Park Restoration Project

1. Designed Versus Delineated Palustrine Habitat. The total intended wetland acreage was approximately 2 acres; 1.5 acres were delineated in 2008. Of the three designed palustrine habitats (Wetland 1, Wetland 2, and pond), the pond and Wetland 2 habitats are closer in acreage to their intended design. Wetland 2 was designed to be 1 acre in size; in 2008, 1.1 acres were delineated. Wetland 2 has exceeded its intended boundaries due to the dominance

of hydrophytic vegetation and wetland hydrology along the swales and along the riparian floodplain. The intended size of the pond was 0.5 acre; in 2008, 0.6 acre was delineated.

Wetland 1 has developed 0.4 acre of wetland, less than the designed goal of approximately one acre. Multiple reasons may be contributing to the slow rate of wetland development in the Wetland 1 basin. For instance, Wetland 1 may not be receiving the anticipated amount of storm flow from Angelica Creek through the diversion inlet structure due to the frequency of large storm events or the elevation of the structure's inlet which limits floodflow contributions. Dr. David Osgood of Albright College is currently monitoring storm events and groundwater elevations in the park and may be able to provide data in subsequent years to determine if adequate floodflow is available to develop the entire Wetland 1 area into wetland.

Another reason for the slow development of Wetland 1 may be related to its substrate. While the sediment basin behind the rock filter berm contains silt and remains saturated during most of the season, the area downgradient contains cobble and does not retain surface hydrology for extended periods. Following storm events, surface water infiltrates rapidly and hydric conditions may not persist long enough to allow hydrophytes to dominant. At this time, the cover is a mix of upland and wetland species. During subsequent monitoring events, the vegetative cover will be documented and compared to flood frequency and groundwater data. This information should help to determine whether a hydrophytic cover will dominate based on the frequency of flood events and the seasonal high water table elevation.

2. Stream Corridor and Bioengineering Measures. Along Angelica Creek, the stream restoration measures included regrading of the streambanks, stabilizing them with vegetation and coir bio-logs, and protecting them from streamflows with rock and log vanes, as well as root wads. The majority of the stream corridor remains fully vegetated and stabilized except for a small section below Rock Cross Vane #3 (Appendix G, Photograph T). In this area, the coir bio-logs are no longer present and the bank has been undercut, leaving a 20-foot section of excised bank and a gravel bar that has developed on the opposite bank.

The visual observations of the rock and log vanes, as well as the snags, indicates that they are all functioning as designed. In particular, the snags provide habitat for macroinvertebrate that cling to woody debris and have created small pools that serve as resting and feeding areas for migrating fish. Several of the rock vanes have also created large pools in areas where silt deposits have been washed away to reveal deeper clay layers. In particular, the pools downstream of Rock Cross Vanes #4 and #6 are approximately 3 and 4 feet deep, respectfully, and typically contain fish. It was, however, noted that several of the log vanes could have extended farther into the stream corridor as to provide better bank protection and develop small pools.

3. Vegetative Cover and Diversity. The vegetative cover throughout the site appears to be close to 100 percent, not including maintained trails and clearings. The percent vegetative cover measure within the quadrats is 99.7 percent. This suggests that the site has developed a dense composition of vegetation and, following construction activities, compacted or poor soil conditions are not prevalent. Surveyors did note that one area within Wetland 1, east of the boardwalk, was sparsely vegetated and contained cobble. This area will be monitored to determine if the soil substrate is prohibiting the establishment of a dense herbaceous cover.

Overall plant diversity throughout the site is high, which is beneficial for the maintenance of wildlife diversity. The herbaceous community throughout the site shows a mix of seeded/planted and volunteer species. Of the 67 species identified in the herbaceous layer, 32 species (48 percent) were volunteer organisms. Seven of these 32 species are considered invasive species, while two of the seven are listed as Pennsylvania Noxious Weeds. These invasive species will need to be actively managed as they can potentially out-compete desirable seeded and volunteer species and would decrease overall plant and wildlife diversity within the park.

The majority of planted trees and shrubs are alive and thriving at the site. However, approximately six percent of trees are stressed and two percent are missing. These missing trees are *Pinus strobus* (white pine) and *Betula nigra* (river birch); it is likely that they were never planted and other substitute species were planted elsewhere at the site. As noted in this report, problem areas for shrubs survivorship include the maintenance road access area (near the S.R.

0010 bridge) and the new pedestrian bridge, due to gravel washout. If these problems persist, the dogwood shrubs may not survive and replacement would be recommended elsewhere along the streambank.

4. Angelica Creek Aquatic Habitat. In 2008, the existing benthic macroinvertebrate community was observed as a broad indicator of overall stream health. According to the PADEP (Chapter 93, PA Code), the entire basin of Angelica Creek is listed as a Cold Water Fishery (CWF), while the PADEP permit indicates that the area upstream from the previous lake bed is being managed as a wild trout fishery. As such, the waterway should be able to maintain native and stocked species of fish that require water at a temperature less than 70 degrees Fahrenheit to grow and reproduce. These species include varieties of trout, dace, and sculpins. A diverse macroinvertebrate community at the site would provide a food source for fish and other vertebrate species such as amphibians and birds.

Using the Pennsylvania PTI indices and other metrics, this segment of Angelica Creek appears to show a fair water quality and a moderate level of macroinvertebrate diversity. This is similar to the long-term sampling of Angelica Creek performed by Stroud Water Research Center at a point in the upper watershed of the creek (Stroud Water Research Center, accessed September 25, 2008). According to Stroud Center's data, the water quality in the upper watershed was also listed as "fair" according to their metrics, which differed from ours. While not conclusive, this comparison suggests that water quality within Angelica Creek has not changed significantly within a year post-construction. This would be expected due to the high level of disturbance associated with construction activities.

5. Wildlife Usage. As of 2008, the site is being utilized by species common to rural and suburban settings. Terrestrial insects, birds, amphibians, and mammals were observed during multiple site visits. The site was also designed to encourage the nesting of wood ducks, bluebirds, and bats. As of 2008, no wood ducks or bats were observed at the site. Bluebirds were observed within the wetland and meadow habitats during the August 2008 site visit. However, they were not observed within the constructed nesting boxes. These species may visit or inhabit the site as beneficial conditions continue to develop.

B. Recommendations for Future Site Management

As noted in this report, the site appears to have stable wetland, open water, floodplain, and meadow habitats after the first growing season. The site is used by local fauna, has been colonized by volunteer plant species, and is a popular site for passive and active recreation. The site has also been used by the Nolde Environmental Education Center, the North East Middle School, the Reading High School, and local college students for environmental workshops. The environmental education component of this site will continue to develop over time with the construction of the environmental education center at the boathouse.

The intended acreage of wetland habitat has not fully developed following the first year of monitoring. While Wetland 2 has developed more than the intended acreage (1.1 acre actual vs. 1 acre intended), Wetland 1 has only developed pockets of wetland habitat. While it is possible that additional wetland area may develop, alterations to the physical structures (rock filter berm and diversion structure) may be required. Due to changes in channel elevation near the diversion structure, possibly associated with Rock Cross Vane #3, the structure's intake may be too high to allow adequate storm flow from Angelica Creek into Wetland 1. Additional studies should be made to determine if lowering the elevation of the diversion structure will positively affect the hydrology of the Wetland 1 basin. Other options may include removing or opening up the rock filter berm and repositioning Rock Cross Vane #3 to limit down-cutting of the channel.

Segments of Angelica Creek may require additional stabilization measures. Eroded banks were specifically noted between Rock Cross Vane #3 and the snag approximately 300 feet downstream. If this bank section continues to be undercut, remediation measures, such as rock armoring and slope regrading, may be recommended.

Sections of the riparian buffer and Wetland 1 are also being negatively impacted by gravel washout from the steep sections of unpaved path and maintenance road. Gravel wash has been noted at the edge of the Wetland 1 basin near the boardwalk and the hillside. Gravel wash has also been noted on the floodplain adjacent to the new pedestrian bridge, originating from a construction road along the hillside and the trail section near the S.R. 0010 bridge. Both areas

show signs of stressed vegetation. Gravel should be removed from the site, and the paths should be stabilized to limit further disturbance. Stabilization of the path could involve paving or the development of a stabilized gutter system.

Finally, the presence of invasive species poses a concern for the overall health of the vegetative communities and wildlife diversity. Seven invasive species have entrenched along the streambanks and within the wetlands during the first growing season following construction. Of these seven, purple loosestrife, Japanese hops, Pennsylvania smartweed, and mile-a-minute were the most common. The reduction and eventual eradication of these species using Best Management Practices should be a priority to maintain the vegetative diversity and overall habitat function of the site. The 2008 Maintenance Plan will be an important guide for the control and eradication of invasive species within Angelica Creek Park.

REFERENCES

REFERENCES

- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. U.S. Fish and Wildlife Service, FWS/OBS-79/31. U.S. Government Printing Office, Washington, D.C.
- Environmental Laboratory. 1987. U.S. Army Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-01. U.S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.
- Lathrop, J. et al., "Project Heartbeat Volunteer Monitoring Handbook, Fall 1994." Save Our Streams (SOS): Fall 1994.
- Macbeth Division of Kollmorgen Instruments Corporation. 1994. *Munsell Soil Color Charts*, revised edition. Newburgh, New York.
- Mitchell, Mark K. and William Stapp. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools*. Dexter. 1996 MI: Thomson-Short, Inc.
- Sabine, B.J., ed. 1993. *National List of Plant Species that Occur in Wetlands, Region 1 - Northeast*. Resource Management Group, Inc. Grand Haven, Michigan.
- U.S. Geological Survey (USGS). 1957. Trenton East, NJ/PA Topographic Quadrangle. Photorevised 1981. Washington, D.C.
- Wentworth, T.R., G.P. Johnson, and R.L. Kologiski. 1988. *Designation of Wetlands by Weighted Averages of Vegetation Data: A Preliminary Evaluation*. American Water Resources Association. Water Resources Bulletin, Vol. 24, No. 2. North Carolina Agricultural Research Service. Raleigh, North Carolina.

Online Bibliographic Sources:

- Allegheny College. "Pollution Tolerance Index (PTI). 1998 – Present.
<http://creekconnections.allegheny.edu/TeacherResourceCenter/POLLUTION%20TOLERANCE%20INDEX.doc>. Accessed October 2, 2008.
- Animal and Plant Health Inspection Service. "Federal Noxious Weed List." United States Department of Agriculture: August 2008. http://www.aphis.usda.gov/plant_health/lant_pest_info/weeds/downloads/weedlist2006.pdf. Accessed September 30, 2008.
- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition." EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. <http://www.epa.gov/OWOW/monitoring/techmon.html>. Accessed October 2, 2008.

Hoosier Riverwatch. "Volunteer Stream Monitoring Training Manual." March 2005. Online source: http://www.in.gov/dnr/files/00_Hoosier-Riverwatch.pdf. Accessed October 2, 2008.

Pennsylvania Code, Chapter 93: Commonwealth of Pennsylvania. *The Pennsylvania Code*, Title 25, Chapter 93: Water Quality Standards. <http://www.pacode.com/secure/data/025/chapter93/chap93toc.html>. Accessed September 30, 2008.

Pennsylvania Department of Agriculture. "Pennsylvania Noxious Weed Control List." July 2008. <http://www.agriculture.state.pa.us/agriculture/lib/agriculture/plantindustryfiles/NoxiousWeedControlList.pdf>. Accessed September 30, 2008.

Plant Conservation Alliance-Alien Plant Working Group. "Weeds Gone Wild: Alien Plant Invaders of Natural Areas." <<http://www.nps.gov/plants/alien/index.htm>> Last updated: 19-Mar-2008. Accessed October 2, 2008.

Stroud Water Research Center. *Schuylkill Project – Northwest Schuylkill Basin*. 2008. <<http://www.stroudcenter.org/schuylkill/sites/site009.htm>>. Accessed September 25, 2008.

United States Department of Agriculture. National Water and Climate Center Technical Note 99-1, Stream Visual Assessment Protocol. December 1998. www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf>. Accessed October 2, 2008.

APPENDIX A:
QUADRAT DATA AND
SUMMARY

Appendix A:
Quadrat Data and Summary

Quadrat Data					
Site Name:		Angelica Creek Restoration Site		Investigators: SLJ/JG	
Quadrat ID:		A+000		Date: 8/13/2008	
HERBACEOUS VEGETATION:					
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
soft rush	Juncus effusus	30	FACW+	1.67	0.501
blue vervain	Verbena hastata	25	FACW+	1.67	0.4175
switchgrass	Panicum virgatum	20	FAC	3	0.6
fowl bluegrass	Poa palustris	20	FAC	3	0.6
square-stemmed monkey flower	Mimulus ringens	5	OBL	1	0.05
TOTAL:		100		Plot Indic.Val.	2.1685

Quadrat Data							
Site Name:		Angelica Creek Restoration Site		Investigators:		SLJ/JG	
Quadrat ID:		A+100		Date:		8/13/2008	
HERBACEOUS VEGETATION:							
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value		
switchgrass	Panicum virgatum	45	FAC	3	1.35		
fowl bluegrass	Poa palustris	40	FAC	3	1.2		
slender rush	Juncus tenuis	T	FAC-	3.33	0		
partridge pea	Chamaecrista fasciculata	10	FACU	4	0.4		
bare ground	-	5	-	-	0		
TOTAL:		100		Plot Indic.Val.	2.95		

Quadrat Data					
Site Name:		Angelica Creek Restoration Site		Investigators: SLJ/JG	
Quadrat ID:		A+200		Date: 8/13/2008	
HERBACEOUS VEGETATION:					
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
white clover	Trifolium repens	20	FACU-	4.33	0.866
switchgrass	Panicum virgatum	30	FAC	3	0.9
fowl bluegrass	Poa palustris	35	FAC	3	1.05
slender rush	Juncus tenuis	15	FAC-	3.33	0.4995
	TOTAL:	100		Plot Indic.Val.	3.3155

Quadrat Data

Site Name: Angelica Creek Restoration Site
Quadrat ID: A+300

Investigators: SLJ/JG
Date: 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
blue vervain	<i>Verbena hastata</i>	10	FACW+	1.67	0.167
yellow nutsedge	<i>Cyperus esculentus</i>	20	FACW	2	0.4
PA smartweed	<i>Polygonum pensylvanicum</i>	5	FACW	2	0.1
devil's beggarstick	<i>Bidens frondosa</i>	5	FACW	2	0.1
slender rush	<i>Juncus tenuis</i>	20	FAC-	3.33	0.666
purple loosestrife	<i>Lythrum salicaria</i>	20	FACW+	1.67	0.334
tussock sedge	<i>Carex stricta</i>	20	OBL	1	0.2
TOTAL:		100		Plot Indic.Val.	1.967

Quadrat Data

Site Name: Angelica Creek Restoration Site
Quadrat ID: A END

Investigators: SLJ/JG
Date: 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
evening primrose	<i>Oenothera biennis</i>	20	FACU-	3.67	0.734
burdock	<i>Arctium minus</i>	10	NL	3	0.3
switchgrass	<i>Panicum virgatum</i>	10	FAC	3	0.3
fowl bluegrass	<i>Poa palustris</i>	10	FAC	3	0.3
black eyed susan	<i>Rudbeckia hirta</i>	20	FACU-	3.67	0.734
white heath aster	<i>Symphotrichum ericoides</i>	5	UPL	5	0.25
slender rush	<i>Juncus tenuis</i>	15	FAC-	3.33	0.4995
partridge pea	<i>Chamaecrista fasciculata</i>	10	FACU	4	0.4
TOTAL:		100		Plot Indic.Val.	3.5175

Quadrat Data					
Site Name:	Angelica Creek Restoration Site		Investigators:	SLJ/JG	
Quadrat ID:	B+000		Date:	8/13/2008	
HERBACEOUS VEGETATION:					
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
Canadian horseweed	<i>Conyza canadensis</i>	15	UPL	5	0.75
Fuller's teasel	<i>Dipsacus fullonum</i>	10	I, NI	3	0.3
brown-eyed susan	<i>Rudbeckia triloba</i>	10	FACU	4	0.4
plains coreopsis	<i>Coreopsis tinctoria</i>	60	FAC-	3.33	1.998
wild carrot	<i>Daucus carota</i>	5	I, NI	3	0.15
	TOTAL:	100		Plot Indic.Val.	3.598

Quadrat Data					
Site Name:	Angelica Creek Restoration Site		Investigators:	SLJ/JG	
Quadrat ID:	B+100		Date:	8/13/2008	
HERBACEOUS VEGETATION:					
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
rough goldenrod	Solidago rugosa	15	FAC	3	0.45
purple loosestrife	Lythrum salicaria	35	FACW+	1.67	0.5845
reed canarygrass	Phalaris arundinacea	25	FACW+	1.67	0.4175
switchgrass	Panicum virgatum	5	FAC	3	0.15
Canadian horseweed	Conyza canadensis	5	UPL	5	0.25
tussock sedge	Carex stricta	10	OBL	1	0.1
pilewort	Erechtites hieracifolia	5	FACU	4	0.2
	TOTAL:	100		Plot Indic.Val.	2.152

Quadrat Data					
Site Name:	Angelica Creek Restoration Site	Investigators:	SLJ/JG		
Quadrat ID:	B+200	Date:	8/13/2008		
HERBACEOUS VEGETATION:					
Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
rough barnyard grass	Echinichloa crusgalli	35	FACW+	1.67	0.5845
devil's beggarstick	Bidens frondosa	40	FACW	2	0.8
boneset	Eupatorium perfoliatum	10	FACW+	1.67	0.167
purple loosestrife	Lythrum salicaria	15	FACW+	1.67	0.2505
	TOTAL:	100		Plot Indic.Val.	1.802

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+300 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
square-stemmed monkey flower	<i>Mimulus ringens</i>	15	OBL	1	0.15
purple loosestrife	<i>Lythrum salicaria</i>	30	FACW+	1.67	0.501
dark green bulrush	<i>Scirpus atrovirens</i>	40	OBL	1	0.4
Japanese hops	<i>Humulus japonicus</i>	5	FACU	4	0.2
devil's beggarstick	<i>Bidens frondosa</i>	10	FACW	2	0.2
TOTAL:		100		Plot Indic.Val.	1.451

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+400 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
curly dock	<i>Rumex crispus</i>	35	FACU	4	1.4
black eyed susan	<i>Rudbeckia hirta</i>	20	FACU-	3.67	0.734
PA smartweed	<i>Polygonum pensylvanicum</i>	25	FACW	2	0.5
switchgrass	<i>Panicum virgatum</i>	5	FAC	3	0.15
fowl bluegrass	<i>Poa palustris</i>	5	FAC	3	0.15
common sowthistle	<i>Sonchus arvensis</i>	5	UPL	5	0.25
green foxtail	<i>Setaria faberi</i>	5	UPL	5	0.25
TOTAL:		100		Plot Indic.Val.	3.434

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+500 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
Canadian horseweed	<i>Conyza canadensis</i>	20	UPL	5	1
devil's beggarstick	<i>Bidens frondosa</i>	15	FACW	2	0.3
purple loosestrife	<i>Lythrum salicaria</i>	5	FACW+	1.67	0.0835
black eyed susan	<i>Rudbeckia hirta</i>	25	FACU-	4.33	1.0825
plains coreopsis	<i>Coreopsis tinctoria</i>	5	FAC-	3.33	0.1665
green foxtail	<i>Setaria faberi</i>	T	UPL	5	0
soft rush	<i>Juncus effusus</i>	10	FACW+	1.67	0.167
reed canarygrass	<i>Phalaris arundinacea</i>	15	FACW+	1.67	0.2505
fowl bluegrass	<i>Poa palustris</i>	5	FAC	3	0.15
TOTAL:		100		Plot Indic.Val.	3.2

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+600 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
blue vervain	<i>Verbena hastata</i>	10	FACW+	1.67	0.167
purple loosestrife	<i>Lythrum salicaria</i>	25	FACW+	1.67	0.4175
swamp smartweed	<i>Polygonum hydropiperoides</i>	15	OBL	1	0.15
reed canarygrass	<i>Phalaris arundinacea</i>	25	FACW+	1.67	0.4175
Japanese hops	<i>Humulus japonicus</i>	5	FACU	4	0.2
curly dock	<i>Rumex crispus</i>	5	FACU	4	0.2
burdock	<i>Arctium minus</i>	5	NL	3	0.15
evening primrose	<i>Oenothera biennis</i>	5	FACU-	3.67	0.1835
TOTAL:		100		Plot Indic.Val.	1.8855

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+700 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
black eyed susan	<i>Rudbeckia hirta</i>	50	FACU-	3.67	1.835
plains coreopsis	<i>Coreopsis tinctoria</i>	25	FAC-	3.33	0.8325
partridge pea	<i>Chamaecrista fasciculata</i>	15	FACU	4	0.6
annual ragweed	<i>Ambrosia artemisiifolia</i>	10	FACU	4	0.4
TOTAL:		100		Plot Indic.Val.	3.6675

Quadrat Data

Site Name: Angelica Creek Restoration Site **Investigators:** SLJ/JG
Quadrat ID: B+800 **Date:** 8/13/2008

HERBACEOUS VEGETATION:

Common Name	Scientific Name	% Cover	Indicator Status	Indicator Value	Weighted Value
black eyed susan	<i>Rudbeckia hirta</i>	55	FACU-	3.67	2.0185
reed canarygrass	<i>Phalaris arundinacea</i>	10	FACW+	1.67	0.167
purple loosestrife	<i>Lythrum salicaria</i>	10	FACW+	1.67	0.167
chicory	<i>Chicorium intybus</i>	25	NL	3	0.75
TOTAL:		100		Plot Indic.Val.	3.1025

APPENDIX B:
COMPOSITE VEGETATION
LIST BY HABITAT

Appendix B:
Composite Vegetation Lists By Habitat

Composite List: Deep Pond

<i>Scientific Name</i>	Common Name	Volunteer Species (Y/N)
<i>Hypericum mutilum</i>	dwarf St. John's wort	Y
<i>Iris versicolor</i>	blueflag iris	N
<i>Ludwigia palustris</i>	marsh seedbox	Y
<i>Lythrum salicaria</i>	purple loosestrife	Y*
<i>Peltandra virginica</i>	arrow arum	N
<i>Polygonum persicaria</i>	lady's tearthumb	Y
<i>Pontederia cordata</i>	pickerel weed	N
<i>Scirpus atrovirens</i>	common bulrush	N
<i>Typha latifolia</i>	broadleaf cattail	Y

* = invasive species

Composite List: Wetland 1

<i>Scientific Name</i>	Common Name	Volunteer Species (Y/N)
<i>Aster novae-angliae</i>	New England aster	N
<i>Bidens frondosa</i>	devil's beggarstick	N
<i>Carex lurida</i>	shallow sedge	N
<i>Carex scoparia</i>	blunt broom grass	N
<i>Carex stricta</i>	tussock sedge	Y
<i>Carex vulpinoidea</i>	fox sedge	N
<i>Chamaecrista fasciculata</i>	partridge pea	N
<i>Conyza canadensis</i>	horseweed	Y
<i>Cyperus esculentus</i>	yellow nutsedge	Y
<i>Daucus carota</i>	wild carrot	Y
<i>Elymus virginicus</i>	Virginia wild rye	N
<i>Erigeron annuus</i>	annual fleabane	Y
<i>Eupatorium maculatum</i>	spotted joe pye weed	N
<i>Eupatorium perfoliatum</i>	boneset	N
<i>Glyceria grandis</i>	American mannagrass	N
<i>Helenium autumnale</i>	common sneezeweed	N
<i>Heliopsis helianthoides</i>	ox-eye sunflower	N
<i>Humulus japonicus</i>	Japanese hops	Y*
<i>Iris versicolor</i>	blue flag	N
<i>Juncus effusus</i>	soft rush	N
<i>Juncus tenuis</i> , PA Ecotype	slender rush	N
<i>Lilium superbum</i>	Turk's cap lily	N
<i>Linaria vulgaris</i>	butter-and-eggs	Y
<i>Ludwigia palustris</i>	marsh seedbox	Y
<i>Lythrum salicaria</i>	purple loosestrife	Y*
<i>Mimulus ringens</i>	square-stemmed monkey flower	N
<i>Oxalis europaea</i>	yellow woodsorrel	Y
<i>Panicum virgatum</i>	switchgrass	N
<i>Persicaria perfoliata</i>	mile-a-minute	Y*
<i>Poa palustris</i>	fowl bluegrass	N
<i>Polygonum pensylvanicum</i>	PA smartweed	Y
<i>Polygonum perfoliatum</i>	Asiatic tearthumb	Y
<i>Robinia psuedoacacia</i>	black locust	Y*
<i>Salix nigra</i>	black willow	Y
<i>Scirpus atrovirens</i>	green bulrush	N
<i>Sparganium eurycarpum</i>	giant bur reed	N
<i>Trifolium repens</i>	white clover	Y
<i>Verbena hastata</i>	blue vervain	N
<i>Vernonia gigantea</i>	giant ironweed	N

* = invasive species

Composite List: Wetland 2

Scientific Name	Common Name	Volunteer Species (Y/N)
<i>Aster novae-angliae</i>	New England aster	N
<i>Bidens frondosa</i>	devil's beggarstick	N
<i>Carex lurida</i>	shallow sedge	N
<i>Carex scoparia</i>	blunt broom grass	N
<i>Carex stricta</i>	tussock sedge	Y
<i>Carex vulpinoidea</i>	fox sedge	N
<i>Conyza canadensis</i>	Canadian horseweed	Y
<i>Cyperus esculentus</i>	yellow nutsedge	Y
<i>Echinichloa crusgalli</i>	rough barnyard grass	Y
<i>Elymus virginicus</i>	Virginia wild rye	N
<i>Erechtites hieracifolia</i>	pilewort	Y
<i>Eupatorium maculatum</i>	spotted joe pye weed	N
<i>Eupatorium perfoliatum</i>	boneset	N
<i>Helenium autumnale</i>	common sneezeweed	N
<i>Heliopsis helianthoides</i>	ox-eye sunflower	N
<i>Humulus japonicus</i>	Japanese hops	Y*
<i>Iris versicolor</i>	blue flag	N
<i>Juncus effusus</i>	soft rush	N
<i>Juncus tenuis</i> , PA Ecotype	slender rush	N
<i>Lilium superbum</i>	Turk's cap lily	N
<i>Ludwigia palustris</i>	marsh seedbox	Y
<i>Lythrum salicaria</i>	purple loosestrife	Y*
<i>Mimulus ringens</i>	square-stemmed monkey flower	N
<i>Panicum virgatum</i>	switchgrass	N
<i>Peltandra virginica</i>	arrow arum	N
<i>Persicaria perfoliata</i>	mile-a-minute	Y*
<i>Phalaris arundinacea</i>	reed canary grass	Y*
<i>Poa palustris</i>	fowl bluegrass	N
<i>Polygonum hydropiperoides</i>	marsh smartweed	Y
<i>Polygonum pensylvanicum</i>	PA smartweed	Y
<i>Polygonum perfoliatum</i>	Asiatic tearthumb	Y
<i>Pontederia cordata</i>	pickerel weed	N
<i>Robinia psuedoacacia</i>	black locust	Y*
<i>Rumex crispus</i>	curly dock	Y
<i>Salix nigra</i>	black willow	Y
<i>Scirpus atrovirens</i>	green bulrush	N
<i>Scirpus validus</i>	soft stem bulrush	N
<i>Setaria faberi</i>	green foxtail	Y
<i>Solidago rugosa</i>	rough goldenrod	Y
<i>Sonchus arvensis</i>	common sowthistle	Y
<i>Verbena hastata</i>	blue vervain	N
<i>Vernonia gigantea</i>	giant ironweed	N

* = invasive species

Composite List: Meadow

<i>Scientific Name</i>	Common Name	Volunteer Species (Y/N)
<i>Ambrosia artemisiifolia</i>	annual ragweed	N
<i>Asclepias syriaca</i>	common milkweed	N
<i>Aster novae-angliae</i>	New England aster	N
<i>Chamaecrista fasciculata</i>	partridge pea	N
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy	N
<i>Cichorium intybus</i>	blue chicory	N
<i>Conyza canadensis</i>	Canadian horseweed	Y
<i>Coreopsis tinctoria</i>	plains coreopsis	N
<i>Daucus carota</i>	wild carrot	Y
<i>Desmodium canadense</i>	showy tick trefoil	N
<i>Dipsacus fullonum</i>	Fuller's teasel	Y
<i>Helenium autumnale</i>	common sneezeweed	N
<i>Heliopsis helianthoides</i>	ox-eye sunflower	N
<i>Humulus japonicus</i>	Japanese hops	Y*
<i>Lythrum salicaria</i>	purple loosestrife	Y*
<i>Panicum virgatum</i>	switch grass	N
<i>Phalaris arundinacea</i>	reed canarygrass	Y*
<i>Phragmites australis</i>	common reed	Y*
<i>Poa palustris</i>	fowl bluegrass	N
<i>Robinia pseudoacacia</i>	black locust	Y*
<i>Rudbeckia hirta</i>	black-eyed susan	N
<i>Rudbeckia triloba</i>	brown-eyed susan	Y
<i>Oenothera biennis</i>	evening primrose	Y
<i>Arctium minus</i>	burdock	Y
<i>Symphotrichum ericoides</i>	white heath aster	Y
<i>Juncus tenuis</i>	slender rush	N

* = invasive species

Composite List: Riverine Riparian

<i>Scientific Name</i>	Common Name	Volunteer Species (Y/N)
<i>Ambrosia artemisiifolia</i>	annual ragweed	N
<i>Andropogon scoparius</i>	little bluestem	N
<i>Arctium minus</i>	burdock	Y
<i>Asclepias incarnata</i>	swamp milkweed	N
<i>Asclepias syriaca</i>	common milkweed	N
<i>Bidens frondosa</i>	devil's beggarstick	N
<i>Carex lurida</i>	shallow sedge	N
<i>Carex stricta</i>	tussock sedge	Y
<i>Chamaecrista fasciculata</i>	partridge pea	N
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy	N
<i>Cichorium intybus</i>	blue chicory	N
<i>Conyza canadensis</i>	Canadian horseweed	Y
<i>Coreopsis tinctoria</i>	plains coreopsis	N
<i>Cyperus esculentus</i>	yellow nutsedge	Y
<i>Daucus carota</i>	wild carrot	Y
<i>Echinichloa crusgalli</i>	rough barnyard grass	Y
<i>Erechtites hieracifolia</i>	pilewort	Y
<i>Eupatorium maculatum</i>	spotted joe pye weed	N
<i>Eupatorium perfoliatum</i>	boneset	N
<i>Helenium autumnale</i>	common sneezeweed	N
<i>Humulus japonicus</i>	Japanese hops	Y*
<i>Juncus effusus</i>	soft rush	N
<i>Juncus tenuis, PA Ecotype</i>	slender rush	N
<i>Lythrum salicaria</i>	purple loosestrife	Y*
<i>Oenothera biennis</i>	evening primrose	Y
<i>Persicaria perfoliata</i>	mile-a-minute	Y*
<i>Phalaris arundinacea</i>	reed canarygrass	Y*
<i>Poa palustris</i>	fowl bluegrass	N
<i>Polygonum hydropiperoides</i>	swamp smartweed	Y
<i>Polygonum pensylvanicum</i>	PA smartweed	Y
<i>Polygonum perfoliatum</i>	Asiatic tearthumb	Y
<i>Robinia psuedoacacia</i>	black locust	Y*
<i>Rudbeckia hirta</i>	black-eyed susan	N
<i>Rumex crispus</i>	curly dock	Y
<i>Salix nigra</i>	black willow	Y
<i>Setaria faberi</i>	green foxtail	Y
<i>Solidago rugosa</i>	rough goldenrod	Y
<i>Sonchus arvensis</i>	common sowthistle	Y
<i>Verbena hastata</i>	blue vervain	N

* = invasive species

APPENDIX C:
VEGETATION SEED MIXES
BY HABITAT

Appendix C

Seed Lists by Ecotype

Master List of Seeded Vegetation

Scientific Name	Common Name
<i>Achillea millefolium</i>	white yarrow
<i>Agrostis scabra</i>	ticklegrass (rough bentgrass)
<i>Andropogon gerardii</i> , <i>Niagara</i>	Niagara big bluestem
<i>Andropogon scoparius</i> , <i>Camper</i>	little bluestem, camper
<i>Asclepias incarnata</i>	swamp milkweed
<i>Asclepias syriaca</i>	common milkweed
<i>Asclepias tuberosa</i>	butterfly milkweed
<i>Aster novae-angliae</i>	New England aster
<i>Aster Prenanthoides</i>	zigzag aster
<i>Aster novi-belgi</i>	New York aster
<i>Aster umbellatus</i>	flat topped white aster
<i>Baptisia australis</i> , <i>WV ecotype</i>	blue false indigo, WV ecotype
<i>Bidens frondosa</i>	beggar ticks
<i>Bouteloua curtipendula</i> , <i>Butte</i>	butte side oats grama
<i>Bromus altissima</i>	wild brome grass
<i>Bromus ciliatus</i>	fringed brome grass
<i>Caltha palustris</i>	marsh marigold
<i>Carex baileyi</i>	Bailey's sedge
<i>Carex comosa</i>	cosmos/bristly sedge
<i>Carex comosa</i>	cosmos/bristly sedge
<i>Carex crinita</i>	fringed (nodding) sedge
<i>Carex lupulina</i>	hop sedge
<i>Carex lurida</i>	lurid/shallow sedge
<i>Carex scoparia</i>	blunt broom sedge
<i>Carex stipata</i>	awl sedge
<i>Carex tuckermanii</i>	Tuckerman's sedge
<i>Carex vulpinoidea</i>	fox sedge
<i>Chamaecrista fasciculata</i>	partridge pea
<i>Chrysanthemum leucanthemum</i>	ox eye daisy
<i>Cichorium intybus</i>	blue chicory
<i>Coreopsis lanceolata</i> , <i>NC Ecotype</i>	lance leaved coreopsis, NC ecotype
<i>Coreopsis tinctoria</i>	plains coreopsis
<i>Cornus amomum</i>	silky dogwood
<i>Desmodium canadense</i>	showy tick trefoil
<i>Elymus canadensis</i>	Canada wild rye
<i>Elymus riparius</i>	riverbank wild rye
<i>Elymus villosus</i>	silky wild rye
<i>Elymus virginicus</i>	Virginia wild rye
<i>Eupatorium fistulosum</i>	joe pye weed
<i>Eupatorium maculatum</i>	spotted joe pye weed
<i>Eupatorium perfoliatum</i>	boneset
<i>Euthamia graminifolia</i>	grass leaved goldenrod
<i>Festuca ovina</i>	sheep fescue, variety not stated
<i>Glyceria canadensis</i>	rattlesnake grass
<i>Glyceria striata</i>	fowl mannagrass
<i>Glyceria grandis</i>	American mannagrass
<i>Hamamelis virginiana</i>	witch hazel
<i>Helenium autumnale</i> <i>PA or VA Ecotype</i>	common sneezeweed, PA or VA ecotype

Scientific Name	Common Name
<i>Heliopsis helianthoides</i>	ox-eye sunflower
<i>Hypericum pyramidatum</i>	great St. John's wort
<i>Iris versicolor</i>	blueflag iris
<i>Juncus effusus</i>	soft rush
<i>Juncus tenuis</i> , PA Ecotype	path rush, PA ecotype
<i>Lespedeza capitata</i>	roundhead lespedeza
<i>Liatris spicata</i>	marsh (dense) blazing star (spiked gayfeather)
<i>Lilium superbum</i>	Turk's cap lilly
<i>Lolium multiflorum</i>	annual ryegrass
<i>Lupinus perennis</i>	wild blue lupine
<i>Mimulus ringens</i>	square stemmed monkey flower
<i>Monarda fistulosa</i>	wild bergamot
<i>Panicum amarum</i>	Atlantic coastal panic grass
<i>Panicum virgatum</i> , Shelter	switch grass, shelter
<i>Peltandra virginica</i>	arrow arum
<i>Penstemon digitalis</i>	tall white beard tongue
<i>Penthorum sedoides</i>	ditch stonecrop
<i>Poa palustris</i>	fowl bluegrass
<i>Pontederia cordata</i>	pickerel weed
<i>Rhus typhina</i>	staghorn sumac
<i>Rudbeckia hirta</i> , NC Ecotype	black eyed Susan, NC ecotype
<i>Sambucus canadensis</i>	elderberry
<i>Scirpus acutus</i>	hard stemmed bulrush
<i>Scirpus atrovirens</i>	common bulrush
<i>Scirpus atrovirens</i>	green bulrush
<i>Scirpus polyphyllus</i>	many leaved bulrush
<i>Scirpus validus</i>	soft stem bulrush
<i>Senna hebecarpa</i> , VA or WV Ecotype	wild senna, VA or WV ecotype
<i>Setaria italica</i>	german foxtail millet
<i>Sorghastrum nutans</i> , Holt	indian grass, holt
<i>Sparganium americanum</i>	eastern lesser bur reed
<i>Sparganium eurycarpum</i>	giant bur reed
<i>Tradescantia ohioensis</i>	Ohio spiderwort
<i>Tradescantia virginiana</i> , PA/VA	Virginia spiderwort, PA and VA ecotype blend
<i>Tripsacum dactyloides</i>	eastern gamma grass
<i>Verbena hastata</i>	blue vervain
<i>Vernonia gigantea</i>	giant ironweed
<i>Viburnum dentatum</i>	arrow wood
<i>Zizia aurea</i>	golden Alexanders

Wetland 1 Seed Mix

Scientific Name	Common Name
<i>Asclepias incarnata</i>	swamp milkweed
<i>Aster novae-angliae</i>	New England aster
<i>Aster umbellatus</i>	flat topped white aster
<i>Bidens frondosa</i>	beggar ticks
<i>Bromus altissima</i>	wild brome grass
<i>Caltha palustris</i>	marsh marigold
<i>Carex baileyi</i>	bailey's sedge
<i>Carex comosa</i>	cosmos/bristly sedge
<i>Carex crinita</i>	fringed (nodding) sedge
<i>Carex lupulina</i>	hop sedge
<i>Carex lurida</i>	lurid/shallow sedge
<i>Carex scoparia</i>	blunt broom sedge
<i>Carex stipata</i>	awl sedge
<i>Carex tuckermanii</i>	Tuckerman's sedge
<i>Carex vulpinoidea</i>	fox sedge
<i>Elymus virginicus</i>	Virginia wild rye
<i>Eupatorium fistulosum</i>	joe pye weed
<i>Eupatorium maculatum</i>	spotted joe pye weed
<i>Eupatorium perfoliatum</i>	boneset
<i>Glyceria canadensis</i>	rattlesnake grass
<i>Glyceria striata</i>	fowl mannagrass
<i>Glyceria grandis</i>	American mannagrass
<i>Helenium autumnale</i> PA or VA Ecotype	common sneezeweed, PA or VA ecotype
<i>Heliopsis helianthoides</i>	ox-eye sunflower
<i>Iris versicolor</i>	blue flag
<i>Juncus effusus</i>	soft rush
<i>Juncus tenuis</i> , PA Ecotype	path rush, PA ecotype
<i>Lilium superbum</i>	Turk's cap lily
<i>Mimulus ringens</i>	square stemmed monkey flower
<i>Penthorum sedoides</i>	ditch stonecrop
<i>Scirpus acutus</i>	hard stemmed bulrush
<i>Scirpus atrovirens</i>	green bulrush
<i>Scirpus polyphyllus</i>	many leaved bulrush
<i>Scirpus validus</i>	soft stem bulrush
<i>Sparganium americanum</i>	eastern lesser bur reed
<i>Sparganium eurycarpum</i>	giant bur reed
<i>Verbena hastata</i>	blue vervain
<i>Vernonia gigantea</i>	giant ironweed
<i>Zizia aurea</i>	golden Alexanders

Pond/Deep Water Seed/Plug Mix (Wetland 1, Wetland 2)

Scientific Name	Common Name
<i>Iris versicolor</i>	blueflag iris
<i>Peltandra virginica</i>	arrow arum
<i>Pontederia cordata</i>	pickerel weed
<i>Scirpus atrovirens</i>	common bulrush

Meadow Seed Mix

Scientific Name	Common Name
<i>Achillea millefolium</i>	white yarrow
<i>Agrostis scabra</i>	ticklegass (rough bentgrass)
<i>Andropogon gerardii</i> , <i>Niagara</i>	Niagara big bluestem
<i>Andropogon scoparius</i> , <i>Camper</i>	little bluestem, camper
<i>Asclepias syriaca</i>	common milkweed
<i>Asclepias tuberosa</i>	butterfly milkweed
<i>Aster novae-angliae</i>	New England aster
<i>Aster prenanthoides</i> / <i>novi-belgi</i> mix	zigzag aster/New York aster mix
<i>Baptisia australis</i> , <i>WV ecotype</i>	blue false indigo, WV ecotype
<i>Bouteloua curtipendula</i> , <i>Butte</i>	butte side oats grama
<i>Bromus ciliatus</i>	fringed brome grass
<i>Chamaecrista fasciculata</i>	partridge pea
<i>Chrysanthemum leucanthemum</i>	ox eye daisy
<i>Cichorium intybus</i>	blue chicory
<i>Coreopsis lanceolata</i> , <i>NC Ecotype</i>	lance leaved coreopsis, NC ecotype
<i>Coreopsis tinctoria</i>	plains coreopsis
<i>Desmodium canadense</i>	showy tick trefoil
<i>Elymus canadensis</i>	Canada wild rye
<i>Elymus villosus</i>	silky wild rye
<i>Festuca ovina</i>	sheep fescue, variety not stated
<i>Heliopsis helianthoides</i>	ox eye sunflower
<i>Hypericum pyramidatum</i>	great St. John's wort
<i>Lespedeza capitata</i>	roundhead lespedeza
<i>Liatris spicata</i>	marsh (dense) blazing star (spiked gayfeather)
<i>Lolium multiflorum</i>	annual ryegrass
<i>Lupinus perennis</i>	wild blue lupine
<i>Monarda fistulosa</i>	wild bergamot
<i>Panicum amarum</i>	Atlantic coastal panic grass
<i>Panicum virgatum</i> , <i>Shelter</i>	switch grass, shelter
<i>Penstemon digitalis</i>	tall white beard tongue
<i>Poa palustris</i>	fowl bluegrass
<i>Rudbeckia hirta</i> , <i>NC Ecotype</i>	black eyed Susan, NC ecotype
<i>Senna hebecarpa</i> , <i>VA or WV Ecotype</i>	wild senna, VA or WV ecotype blend
<i>Sorghastrum nutans</i> , <i>Holt</i>	Indian grass, holt
<i>Tradescantia ohioensis</i>	Ohio spiderwort
<i>Tradescantia virginiana</i> , <i>PA/VA</i>	Virginia spiderwort, PA and VA ecotype blend
<i>Tripsacum dactyloides</i>	eastern gamma grass
<i>Zizia aurea</i>	golden Alexanders

Wetland 2 Seed Mix

Scientific Name	Common Name
<i>Asclepias incarnata</i>	swamp milkweed
<i>Aster novae-angliae</i>	New England aster
<i>Aster umbellatus</i>	flat topped white aster
<i>Bidens frondosa</i>	beggar ticks
<i>Bromus altissima</i>	wild brome grass
<i>Caltha palustris</i>	marsh marigold
<i>Carex baileyi</i>	bailey's sedge
<i>Carex comosa</i>	cosmos/bristly sedge
<i>Carex crinita</i>	fringed (nodding) sedge
<i>Carex lupulina</i>	hop sedge
<i>Carex lurida</i>	lurid/shallow sedge
<i>Carex scoparia</i>	blunt broom sedge
<i>Carex stipata</i>	awl sedge
<i>Carex tuckermanii</i>	Tuckerman's sedge
<i>Carex vulpinoidea</i>	fox sedge
<i>Elymus virginicus</i>	Virginia wild rye
<i>Eupatorium fistulosum</i>	joe pye weed
<i>Eupatorium maculatum</i>	spotted joe pye weed
<i>Eupatorium perfoliatum</i>	boneset
<i>Glyceria canadensis</i>	rattlesnake grass
<i>Glyceria striata</i>	fowl mannagrass
<i>Glyceria grandis</i>	American mannagrass
<i>Helenium autumnale</i> PA or VA Ecotype	common sneezeweed pa or va ecotype
<i>Helenium autumnale</i> , PA or VA Ecotype	common sneezeweed, pa or va ecotype
<i>Heliopsis helianthoides</i>	ox-eye sunflower
<i>Iris versicolor</i>	blue flag
<i>Juncus effusus</i>	soft rush
<i>Juncus tenuis</i> , PA Ecotype	path rush, pa ecotype
<i>Lilium superbum</i>	Turk's cap lily
<i>Mimulus ringens</i>	square stemmed monkey flower
<i>Penthorum sedoides</i>	ditch stonecrop
<i>Scirpus acutus</i>	hard stemmed bulrush
<i>Scirpus atrovirens</i>	green bulrush
<i>Scirpus polyphyllus</i>	many leaved bulrush
<i>Scirpus validus</i>	soft stem bulrush
<i>Sparganium americanum</i>	eastern lesser bur reed
<i>Sparganium eurycarpum</i>	giant bur reed
<i>Verbena hastata</i>	blue vervain
<i>Vernonia gigantea</i>	giant ironweed
<i>Zizia aurea</i>	golden Alexanders

Riverine Riparian Seed Mix

Scientific Name	Common Name
<i>Andropogon gerardii</i> , <i>Niagara</i>	Niagara big bluestem
<i>Andropogon scoparius</i>	little bluestem
<i>Asclepias incarnata</i>	swamp milkweed
<i>Asclepias syriaca</i>	common milkweed
<i>Aster Prenanthoides</i>	zigzag aster
<i>Baptisia australis</i>	blue false indigo
<i>Carex vulpinoidea</i>	fox sedge
<i>Chamaecrista fasciculata</i>	partridge pea
<i>Cornus amomum</i>	silky dogwood
<i>Desmodium canadense</i>	showy tick trefoil
<i>Elymus riparius</i>	riverbank wild rye
<i>Elymus virginicus</i>	Virginia wild rye
<i>Eupatorium fistulosum</i>	joe pye weed
<i>Eupatorium perfoliatum</i>	boneset
<i>Euthamia graminifolia</i>	grass leaved goldenrod
<i>Glyceria striata</i>	fowl mannagrass
<i>Hamamelis virginiana</i>	witch hazel
<i>Helenium autumnale</i>	common sneezeweed
<i>Heliopsis helianthoides</i>	ox eyed sunflower/false
<i>Juncus effusus</i>	soft rush
<i>Lolium multiflorum</i>	annual ryegrass
<i>Monarda fistulosa</i>	wild bergamot
<i>Panicum Virgatum</i>	switch grass
<i>Penstemon digitalis</i>	tall white beard tongue
<i>Rhus typhina</i>	staghorn sumac
<i>Rudbeckia hirta</i>	black eyed Susan
<i>Sambucus canadensis</i>	elderberry
<i>Setaria italica</i>	German foxtail millet
<i>Sorghastrum nutans</i>	Indian grass
<i>Verbena hastata</i>	blue vervain
<i>Vernonia gigantea</i>	giant ironweed
<i>Viburnum dentatum</i>	arrow wood

APPENDIX D:
WOODY PLANT
SURVIVORSHIP DATA

Appendix D Planted Woody Vegetation Survivorship

Tree Species and Status Key

Status Abbreviation
A = Alive and healthy
S = Alive but stressed
D = Dead
M = Missing

Tree Abbreviation	Scientific Name	Common Name
AS	<i>Acer saccharinum</i>	silver maple
BN	<i>Betula nigra</i>	river birch
CC	<i>Carpinus caroliniana</i>	ironwood
FP	<i>Fraxinus pennsylvanica</i>	green ash
LT	<i>Liriodendron tulipifera</i>	tulip poplar
PO	<i>Palustris occidentalis</i>	sycamore
PS	<i>Pinus strobus</i>	white pine
QP	<i>Quercus palustris</i>	pin oak
QR	<i>Quercus rubra</i>	red oak

Species Abbreviation	Tree #	Status	Notes
AS	3	A	
AS	4	A	
AS	8	A	
AS	43	A	
AS	44	A	
AS	45	A	
AS	49	A	
AS	56	A	
AS	57	A	
AS	58	A	
AS	59	A	
AS	60	S	top dieback
AS	78	A	
BN	5	A	
BN	6	A	
BN	7	A	
BN	27	A	
BN	28	A	
BN	29	A	
BN	30	A	
BN	31	A	
BN	35	M	
BN	37	A	
BN	38	A	
BN	40	A	
BN	41	A	
BN	42	A	
BN	50	A	

BN	51	A	
BN	52	A	
BN	61	A	
BN	62	A	
BN	63	A	
CC	32	A	
CC	33	A	
CC	34	A	
CC	64	A	
CC	65	S	wilted, some brown leaves
CC	66	S	wilted, some brown leaves
CC	67	S	wilted, some brown leaves
CC	68	A	
FP	15	A	
FP	18	A	
LT	53	A	
LT	54	A	
LT	55	A	
PO	1	A	
PO	2	A	
PO	9	A	
PO	10	A	
PO	14	M	missing
PO	19	A	
PO	24	A	
PO	25	A	
PO	26	A	
PO	39	A	new planting, new tag
PO	46	A	
PO	47	A	
PO	48	A	
PO	74	A	
PO	75	S	
PO	76	A	
PS	20	A	
PS	20A	A	new planting
PS	21	A	
PS	22	A	
PS	23	A	
PS	36	A	
PS	87	A	
PS	91	A	missing tag
PS	93	A	missing tag
PS	95	A	missing tag
QP	73	A	
QP	86	A	
QR	11	A	
QR	12	A	
QR	13	A	
QR	16	A	
QR	17	S	side dieback
QR	69	A	
QR	70	A	

QR	71	A	
QR	72	A	
QR	79	A	
QR	80	A	
QR	81	A	
QR	82	A	
QR	83	A	
QR	84	A	
QR	85	A	
QR	88	A	
QR	89	A	replaced tree
QR	90	A	replaced tree
QR	92	A	missing tag
QR	94	A	missing tag
QR	96	A	missing tag
QR	97	A	missing tag
QR	98	A	missing tag
QR	99	A	missing tag
QR	100	A	missing tag

Tree Species	Total Planted and Tagged	#A/S/D/M in 2008			
		Alive, Thriving (A)	Alive, Stressed (S)	Dead (D)	Missing (M)
AS	13	12	1	0	0
BN	20	19	0	0	1
CC	8	5	3	0	0
FP	2	2	0	0	0
LT	3	3	0	0	0
PO	16	14	1	0	1
PS	10	10	0	0	0
QP	2	2	0	0	0
QR	26	25	1	0	0
TOTAL	100	92	6	0	2

APPENDIX E:
BENTHIC
MACROINVERTEBRATE SURVEY

Appendix E:
Macroinvertebrate Sampling and Calculations

Sample	No. Individuals in Sample	Taxa Richness (# Taxa)	EPT Taxa (#EPT Taxa)	Sum EPT Organisms	%EPT	RiverWatch PTI (RW PTI)		Pennsylvania PTI (PA PTI)	
					(Sum EPT Organisms/Total # Organisms)	PTI Value	PTI Rating	Water Quality Score	Water Quality Rating
TK-1-F	121	8	5	89	73%	22	GOOD	29.9	FAIR
TK-1-R	40	6	1	3	8%	15	FAIR	15.5	POOR
TK-1 Composite	161	12	5	92	57%	26	EXCELLENT	33.1	FAIR
TK-2-F	88	12	4	38	43%	23	EXCELLENT	23.5	FAIR
TK-2-R	27	9	3	12	44%	21	GOOD	21.8	FAIR
TK-2-Composite	115	14	4	50	43%	29	EXCELLENT	29.9	FAIR
TK-3-F	64	12	3	34	53%	23	EXCELLENT	27	FAIR
Snag (Composite of 5)	52	9	3	31	60%	20	GOOD	26.5	FAIR

Sample 1A: TK-1-R
Taxa List and %Taxa/ETP

Grid Square	Identified Taxa	Number of Organisms/Taxa
A1	Caddisfly case*	-
A1	Caddisfly-green	2
A1	Rat-tailed midge	1
A1	Stonefly nymph	2
A1	Unknown	1
A2	Alderfly larva	3
A2	Caddisfly larva	2
A2	Mayfly nymph	2
A2	Stonefly nymph	1
A2	Unknown	1
A3	Caddisfly larva	3
A3	Midge Larva	2
A3	Unknown	1
A4	Caddisfly-green	2
A4	Midge larva	1
A5	Caddisfly larva	9
A5	Mayfly larva	2
A5	Stonefly nymph	1
A5	Unknown	1
B1	Alderfly larva	2
B1	Caddisfly larva	1
B2	Caddisfly larva	2
B2	Caddisfly-green	3
B3	Alderfly larva	2
B3	Caddisfly larva	2
B3	Caddisfly-green	2
B3	Stonefly nymph	1
B3	Unknown	1
B4	Caddisfly larva	5
B4	Caddisfly-green	2
B4	Stonefly nymph	1
B4	Unknown	1
B5	Caddisfly larva	4
B5	Caddisfly-green	1
B5	Stonefly nymph	1
C1	Caddisfly larva	2
C1	Caddisfly-green	1
C2	Caddisfly larva	2
C3	Caddisfly larva	2
C3	Caddisfly-green	2
C3	Mayfly nymph	1
C4	Caddisfly larva	2
C4	Caddisfly-green	1
C5	Caddisfly larva	1
D1	Caddisfly-green	1
D1	Mayfly nymph	1
D1	Midge larva	1
D2	Caddisfly-green	1
D2	Fingernail clam	1
D2	Mayfly nymph	1
D2	Midge larva	1
D3	Caddisfly larva	2

D3	Caddisfly-green	3
D4	Caddisfly larva	2
D4	Caddisfly-green	1
D4	Midge larva	2
D4	Stonefly nymph	1
D5	Caddisfly larva	2
D5	Mayfly nymph	1
E1	Mayfly nymph	1
E1	Midge larva	2
E1	Stonefly nymph	1
E2	Caddisfly larva	1
E3	Caddisfly larva	1
E3	Water penny	1
E4	Caddisfly larva	1
E5	Caddisfly larva	2
E5	Mayfly nymph	1
Total Taxa in Sample		121
Total Taxa in Grid		121

*Included to show presence of taxa – not included in final calculations.

Taxa Richness (# Taxa)	8
EPT Taxa (SUM EPT Taxa)	5
Sum EPT Organisms	89
%EPT (Sum EPT Organisms/Total # Organisms)	0.73

Sample 1A: TK-1-R
Riverwatch/Pennsylvania PTI Calculations

Summary Totals		RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Alderfly larva	7	-	2	R
Caddisfly larva	48	1	1	C
Caddisfly larva-green	22	-	1	*
Fingernail clam	1	2	2	R
Mayfly larva	2	1	1	C
Mayfly nymph	8	-	1	*
Midge Larva	16	3	3	C
Rat-tailed midge	1	4	3	R
Stonefly nymph	9	1	1	R
Waterpenny	1	1	1	R
Unknown	6	-	-	
TOTAL	121			
- = not included in this analysis				
* = numbers grouped with rest of order for this analysis				

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	4	4	16
PT Group 2	1	3	3
PT Group 3	1	2	2
PT Group 4	1	1	1
		PTI Value	22
		PTI Rating	GOOD

Pennsylvania PTI (PA PTI)			
		Weighting Factors	Index Values
PT Group 1			
#Rs	2	5	10
#Cs	2	5.6	11.2
#Ds	0	5.3	0
		SUM	21.2
PT Group 2			
#Rs	2	3.2	6.4
#Cs	0	3.4	0
#Ds	0	3	0
		SUM	6.4
PT Group 3			
#Rs	1	1.2	1.2
#Cs	1	1.1	1.1
#Ds	0	1	0
		SUM	2.3
		Water Quality Score	29.9
		Water Quality Rating	FAIR

Sample 1B: TK-1-F
Taxa List and %Taxa/ETP

Grid Square	Identified Taxa	Number of Organisms/Taxa
-	crayfish**	1
A1	Midge fly larva	3
A2	Caddisfly larva	1
A2	Midge fly larva	6
A2	Rat-tailed midge larva	1
A3	Midge fly larva	3
A4	Midge fly larva	4
A5	none	0
B1	none	0
B2	Midge fly larva	5
B3	Aquatic Earthworm	1
B3	Caddisfly larva	1
B3	Midge fly larva	6
B4	Aquatic Earthworm	1
B5	Midge fly larva	1
C1	Caddisfly larva	1
C1	Midge fly larva	2
C2	none	0
C3	none	0
C4	none	0
C5	none	0
D1	none	0
D2	Waterpenny	1
D3	Midge fly larva	1
D4	none	0
D5	none	0
E1	Midge fly larva	1
E2	none	0
E3	none	0
E4	none	0
E5	none	0
	Total Taxa in Sample	40
	Total Taxa in Grid	39

** included in count and calculations; identified in field and not preserved.

Taxa Richness (# Taxa)	6
EPT Taxa (SUM EPT Taxa)	1
Sum EPT Organisms	3
%EPT (Sum EPT Organisms/Total # Organisms)	8%

Sample 1B: TK-1-F
Riverwatch/Pennsylvania PTI Calculations

Summary Totals	RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Aquatic Earthworm	2	4	3
Caddisfly larva	3	1	1
crayfish	1	2	2
Midge fly larva	32	3	3
Rat-tailed midge larva	1	4	-
Waterpenny	1	1	1
TOTAL	40		
- = not included in this analysis			
* = numbers grouped with rest of order for this analysis			

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	2	4	8
PT Group 2	1	3	3
PT Group 3	1	2	2
PT Group 4	2	1	2
PTI Value			15
PTI Rating			FAIR

Pennsylvania PTI (PA PTI)			
	Weighting Factors		Index Values
PT Group 1			
#Rs	2	5	10
#Cs	0	5.6	0
#Ds	0	5.3	0
	SUM		10
PT Group 2			
#Rs	1	3.2	3.2
#Cs	0	3.4	0
#Ds	0	3	0
	SUM		3.2
PT Group 3			
#Rs	1	1.2	1.2
#Cs	1	1.1	1.1
#Ds	0	1	0
	SUM		2.3
Water Quality Score			15.5
Water Quality Rating			POOR

Sample 1: TK-1 Composite
%Taxa/ETP

Taxa Richness (# Taxa)	12
EPT Taxa (SUM EPT Taxa)	5
Sum EPT Organisms	92
%EPT (Sum EPT Organisms/Total # Organisms)	0.57

Riverwatch/Pennsylvania PTI Calculations

TK-1 Composite		RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Aquatic Earthworm	2		4	3 R
Alderfly larva	7	-		2 R
Caddisfly larva	51		1	1 C
Caddisfly larva-green	22	*	*	
Fingernail clam	1		2	2 R
Mayfly larva	2		1	1 C
Mayfly nymph	8	*	*	
Midge Larva	48		3	3 C
Rat-tailed midge	2		4 -	
Stonefly nymph	9		1	1 R
Waterpenny	2		1	1 R
Unknown	6	-	-	
crayfish	1		2	2 R
TOTAL	161			
- = not included in this analysis				
* = numbers grouped with rest of order for this analysis				

RiverWatch PTI (RW PTI)			
	#		
	Taxa	Weighting Factors	Value
PT Group 1	4		16
PT Group 2	2		6
PT Group 3	1		2
PT Group 4	2		2
		PTI Value	26
		PTI Rating	Excellent

**Sample 1: TK-1 Composite
Riverwatch/Pennsylvania PTI Calculations (cont.)**

Pennsylvania PTI (PA PTI)			
Weighting Factors			Index Values
PT Group 1			
#Rs	2	5	10
#Cs	2	5.6	11.2
#Ds	0	5.3	0
SUM			21.2
PT Group 2			
#Rs	3	3.2	9.6
#Cs	0	3.4	0
#Ds	0	3	0
SUM			9.6
PT Group 3			
#Rs	1	1.2	1.2
#Cs	1	1.1	1.1
#Ds	0	1	0
SUM			2.3
Water Quality Score			33.1
Water Quality Rating			FAIR

Sample 2A: TK-2-F
Taxa List and %Taxa/ETP

Grid Square	Identified Taxa	Number of Organisms/Taxa
-	Black Fly larva**	1
-	Damselfly nymph**	1
-	Leech**	1
-	Midge fly larva**	7
-	moth pupae **	1
-	Stonefly larva	1
A1	Caddisfly larva	1
A2	none	0
A3	Caddisfly casing	0
A4	Midge fly larva	2
A5	Caddisfly larva	1
A5	Midge Fly larva	2
B1	none	0
B2	Caddisfly larva	1
B2	Midgefly larva	3
B3	Aquatic Earthworm	1
B3	Midgefly larva	8
B4	Caddisfly larva	2
B4	Midgefly larva	3
B4	Stonefly larva	1
B5	Caddisfly larva	1
B5	Midgefly larva	2
C1	Rat-tailed midge	1
C1	Stonefly (adult)	1
C2	Caddisfly larva	1
C2	Leech	1
C2	Midgefly larva	1
C3	Caddisfly larva	1
C3	Caddisfly larva -green	1
C3	Waterpenny	1
C4	Caddisfly larva	2
C4	Midgefly larva	3
C5	none	0
D1	Caddisfly larva	5
D1	Caddisfly larva -green	1
D2	Caddisfly larva	3
D2	Stonefly larva	1
D3	Caddisfly larva	2
D3	Midge fly larva	3
D3	Stonefly larva	1
D4	Caddisfly larva	2
D4	Midge fly larva	5
D5	Caddisfly larva -green	7
D5	Midge fly larva	3
E1	Caddisfly larva -green	1
E2	Caddisfly larva -green	1
E3	none	0
E4	none	0
E5	none	0
Total Taxa in Sample		88
Total Taxa in Grid		76

Taxa Richness (# Taxa)	12
EPT Taxa (SUM EPT Taxa)	4
Sum EPT Organisms	38
%EPT (Sum EPT Organisms/Total # Organisms)	43%

Sample 2A: TK-2-F
Riverwatch/Pennsylvania PTI Calculations

Summary Totals		RW PTI GROUP#		PA PTI Group	PA PTI Abundance
Aquatic Earthworm	1		4	3	R
Black Fly larva	1		3	3	R
Caddisfly	22		1	1	C
Caddisfly larva -green	11	-		1	*
Damselfly nymph	1		2	2	R
Leech	2		3	3	R
Midge fly larva	42		3	3	C
moth pupae	1	-		-	-
Rat-tailed midge	1		4	-	-
Stonefly larva	4		1	1	R
Stonefly (adult)	1	-		1	*
Waterpenny	1		1	1	R
TOTAL	88				

- = not included in this analysis
 * = numbers grouped with rest of order for this analysis

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	3		12
PT Group 2	1		3
PT Group 3	3		6
PT Group 4	2		2
		PTI Value	23
		PTI Rating	EXCELLENT

Pennsylvania PTI (PA PTI)			
		Weighting Factors	Index Values
PT Group 1			
#Rs	2	5	10
#Cs	1	5.6	5.6
#Ds	0	5.3	0
		SUM	15.6
PT Group 2			
#Rs	1	3.2	3.2
#Cs	0	3.4	0
#Ds	0	3	0
		SUM	3.2
PT Group 3			
#Rs	3	1.2	3.6
#Cs	1	1.1	1.1
#Ds	0	1	0
		SUM	4.7
		Water Quality Score	23.5
		Water Quality Rating	FAIR

Sample 2B: TK-2-R
Taxa List and %Taxa/ETP

Grid Square	Identified Taxa	Number of Organisms/Taxa
B3	Amphipod	1
A3	Aquatic Earthworm	1
D3	Blackfly larva	2
B1	Caddisfly larva	2
B2	Caddisfly larva	3
C4	Caddisfly larva	3
E2	Caddisfly larva	1
D3	Caddisfly larva -green	2
A4	Crayfish (1 inch)	1
A5	leech	1
A1	Midge Fly larva	2
A4	Midge Fly larva	1
B5	Midge fly larva	1
C5	Midge fly larva	2
A2	none	0
B4	none	0
C1	none	0
C2	none	0
C3	none	0
D1	none	0
D2	none	0
D4	none	0
D4	none	0
E1	none	0
C4	Stonefly nymph	1
E3	Unknown	1
E4	Unknown	1
E5	Unknown	1
Total Taxa in Sample		27
Total Taxa in Grid		27

Taxa Richness (# Taxa)	9
EPT Taxa (SUM EPT Taxa)	3
Sum EPT Organisms	12
%EPT (Sum EPT Organisms/Total # Organisms)	0.44

Sample 2B: TK-2-R
Riverwatch/Pennsylvania PTI Calculations

Summary Totals	RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Amphipod	1	2	2 R
Aquatic Earthworm	1	4	3 R
Blackfly larva	2	3	3 R
Caddisfly	9	1	1 C
Caddisfly -green	2	-	1 *
Crayfish	1	2	2 R
leech	1	3	3 R
Midge fly larva	6	3	3 R
Stonefly nymph	1	1	1 R
Unknown	3	-	-
TOTAL	27		
- = not included in this analysis			
* = numbers grouped with rest of order for this analysis			

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	2	4	8
PT Group 2	2	3	6
PT Group 3	3	2	6
PT Group 4	1	1	1
		PTI Value	21
		PTI Rating	GOOD

Pennsylvania PTI (PA PTI)			
	Weighting Factors		Index Values
PT Group 1			
#Rs	1	5	5
#Cs	1	5.6	5.6
#Ds	0	5.3	0
	SUM		10.6
PT Group 2			
#Rs	2	3.2	6.4
#Cs	0	3.4	0
#Ds	0	3	0
	SUM		6.4
PT Group 3			
#Rs	4	1.2	4.8
#Cs	0	1.1	0
#Ds	0	1	0
	SUM		4.8
		Water Quality Score	21.8
		Water Quality Rating	FAIR

Sample 2: TK-2 Composite
%Taxa/ETP

Taxa Richness (# Taxa)	14
EPT Taxa (SUM EPT Taxa)	4
Sum EPT Organisms	50
%EPT (Sum EPT Organisms/Total # Organisms)	0.43

Riverwatch/Pennsylvania PTI Calculations

TK-1 Composite			RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Aquatic Earthworm	2		4	3	R
Black Fly larva	3		3	3	R
Caddisfly	31		1	1	C
Caddisfly larva -green	13		*	*	
Damselfly nymph	1		2	2	R
Leech	3		3	3	R
Midge fly larva	48		3	3	C
moth pupae	1		-	-	-
Rat-tailed midge	1		4	-	
Stonefly larva	5		1	1	R
Stonefly (adult)	1		*	*	
Waterpenny	1		1	1	R
Crayfish	1		2	2	R
Unknown	3		-	-	-
TOTAL	115				
- = not included in this analysis					
* = numbers grouped with rest of order for this analysis					

RiverWatch PTI (RW PTI)			
	#		
	Taxa	Weighting Factors	Value
PT Group 1	3	4	12
PT Group 2	3	3	9
PT Group 3	3	2	6
PT Group 4	2	1	2
		PTI Value	29
		PTI Rating	Excellent

Sample 2: TK-2 Composite
Riverwatch/Pennsylvania PTI Calculations (cont.)

Pennsylvania PTI (PA PTI)			
Weighting Factors			Index Values
PT Group 1			
#Rs	2	5	10
#Cs	1	5.6	5.6
#Ds	0	5.3	0
SUM			15.6
PT Group 2			
#Rs	3	3.2	9.6
#Cs	0	3.4	0
#Ds	0	3	0
SUM			9.6
PT Group 3			
#Rs	3	1.2	3.6
#Cs	1	1.1	1.1
#Ds	0	1	0
SUM			4.7
Water Quality Score			29.9
Water Quality Rating			FAIR

Sample 3: TK-3-R
Taxa List

Grid Square	Identified Taxa	Number of Organisms/Taxa
A1	Caddisfly larva	1
A2	Alderfly larva	1
A2	Caddisfly larva	2
A2	Midge larva	1
A3	Caddisfly larva	2
A3	Unknown	1
A4	Caddisfly larva	1
A4	Mayfly nymph	2
A5	Caddisfly larva	1
A5	Caddisfly-green	1
B1	Caddisfly larva	1
B1	Crane fly larva	1
B1	Mayfly nymph	1
B2	Alderfly larva	1
B2	Caddisfly larva	1
B3	Alderfly larva	1
B3	Caddisfly larva	1
B3	Caddisfly-green	1
B4	Alderfly nymph	1
B4	Caddisfly larva	1
B4	Caddisfly-green	1
B5	Caddisfly larva	2
C1	Caddisfly larva	2
C2	Caddisfly larva	2
C2	Caddisfly-green	1
C2	Mayfly nymph	1
C3	Caddisfly larva	1
C3	Unknown	1
C4	Mayfly nymph	1
C4	Midge larva	1
C5	none	0
D1	Caddisfly larva	2
D1	Crane fly larva	1
D1	Mayfly nymph	1
D1	Midge larva	6
D2	Caddisfly larva	1
D2	Dragonfly nymph	1
D3	none	0
D4	none	0
D5	none	0
E1	Aquatic Earthworm	1
E1	Crane fly larva	1
E1	Midge larva	3

Taxa List (cont.)

E2	Caddisfly larva	2
E2	Horsefly larva	1
E2	Mayfly nymph	1
E2	Midge larva	1
E3	Horsefly larva	1
E4	Aquatic Earthworm	1
E4	Leech	1
E4	Rat-tailedfly larva	1
E5	none	0
In Situ:	crayfish	2
	Total Taxa in Sample	64
	Total Taxa in Grid	62

%Taxa/ETP

Taxa Richness (# Taxa)	12
EPT Taxa (SUM EPT Taxa)	3
Sum EPT Organisms	34
%EPT (Sum EPT Organisms/Total # Organisms)	0.53

Riverwatch/Pennsylvania PTI Calculations

Summary Totals	RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Alderfly larva	4 -	2 R	
Aquatic Earthworm	2	4 3 R	
Caddisfly larva	23	1 1 C	
Caddisfly larva -green	4 -	1 *	
Crane fly larva	3	2 2 R	
crayfish	2	2 2 R	
Dragonfly nymph	1	2 2 R	
Horsefly larva	2 -	-	-
Leech	1	3 3 R	
Mayfly nymph	7	1 1 R	
Midge larva	12	3 3 R	
Rat-tailedfly larva	1	4 -	-
Unknown	2 -		
TOTAL	64		
- = not included in this analysis			
* = numbers grouped with rest of order for this analysis			

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	2	4	8
PT Group 2	3	3	9
PT Group 3	2	2	4
PT Group 4	2	1	2
		PTI Value	23
		PTI Rating	EXCELLENT

Riverwatch/Pennsylvania PTI Calculations (cont.)

Pennsylvania PTI (PA PTI)			
Weighting Factors			Index Values
PT Group 1			
#Rs	1	5	5
#Cs	1	5.6	5.6
#Ds	0	5.3	0
	SUM		10.6
PT Group 2			
#Rs	4	3.2	12.8
#Cs	0	3.4	0
#Ds	0	3	0
	SUM		12.8
PT Group 3			
#Rs	3	1.2	3.6
#Cs	0	1.1	0
#Ds	0	1	0
	SUM		3.6
Water Quality Score			27
Water Quality Rating			FAIR

**Sample 4: Snag Composite
Taxa List**

Grid Square	Identified Taxa	Number of Organisms/Taxa
A1	Fingernail clam	1
A2	Damselfly nymph	1
A2	Dragonfly nymph	2
A2	Midge larva	1
A3	Caddisfly larva	1
A3	Caddisfly-green	2
A3	Midge larva	1
A4	Alderfly larva	2
A4	Unknown	1
A5	Midge larva	1
B1	none	1
B2	Caddisfly larva	1
B2	Midge larva	1
B2	Unknown	1
B3	Caddisfly-green	1
B4	Caddisfly-green	1
B4	Midge larva	1
B5	Caddisfly larva	2
B5	Caddisfly-green	1
C1	Alderfly larva	2
C1	Caddisfly larva	1
C1	Caddisfly-green	1
C2	Damselfly nymph	1
C2	Midge larva	1
C3	Caddisfly larva	1
C3	Damselfly nymph	1
C3	Midge larva	1
C3	Unknown	1
C4	Gilled snail	1
C5	none	1
D1	Midge larva	2
D2	Damselfly nymph	1
D2	Mayfly nymph	2
D3	Damselfly larva	1
D3	Mayfly nymph	1
D3	Unknown	1
D4	Unknown	1
D5	Caddisfly larva	1
E1	Caddisfly larva	2
E1	Midge larva	0
E2	Damselfly nymph	0
E2	Gilled snail	0
E2	Mayfly nymph	1
E3	Damselfly nymph	1
E3	Midge larva	1
E4	Damselfly nymph	1
E5	none	1
TOTAL INDIVIDUALS IN SORTED SAMPLE		52
TOTAL INDIVIDUALS IN SAMPLE		52

Sample 4: Snag Composite

%Taxa/ETP

Taxa Richness (# Taxa)	9
EPT Taxa (SUM EPT Taxa)	3
Sum EPT Organisms	31
%EPT (Sum EPT Organisms/Total # Organisms)	0.6

Summary Totals	RW PTI GROUP#	PA PTI Group	PA PTI Abundance
Alderfly larva	2 -		2 R
Caddisfly larva	10	1	1 C
Caddisfly larva -green	5 -		1 *
Damselfly larva	1	2	2 C
Damselfly nymph	10 -		2 *
Fingernail clam	1	2	2 R
Gilled snail	2	1	1 R
Mayfly nymph	3	1	1 R
Midge larva	13	3	3 C
Unknown	5 -	-	-
TOTAL	52		
- = not included in this analysis			
* = numbers grouped with rest of order for this analysis			

RiverWatch PTI (RW PTI)			
	# Taxa	Weighting Factors	Value
PT Group 1	3		12
PT Group 2	2		6
PT Group 3	1		2
PT Group 4	0		0
		PTI Value	20
		PTI Rating	GOOD

Pennsylvania PTI (PA PTI)			
	Weighting Factors		Index Values
PT Group 1			
	#Rs 2	5	10
	#Cs 1	5.6	5.6
	#Ds 0	5.3	0
	SUM		15.6
PT Group 2			
	#Rs 2	3.2	6.4
	#Cs 1	3.4	3.4
	#Ds 0	3	0
	SUM		9.8
PT Group 3			
	#Rs 0	1.2	0
	#Cs 1	1.1	1.1
	#Ds 0	1	0
	SUM		1.1
		Water Quality Score	26.5
		Water Quality Rating	FAIR

APPENDIX F:
SITE MONITORING
PHOTOGRAPHS



Photograph 1: View of the Wetland 1 basin, from the A+000 transect plot, facing west (August 2008).



Photograph 2: View of deep water pond with submerged vegetation at the edge, from the meadow upland, facing east. A great blue heron was feeding in the pond during the August field view (August 2008).



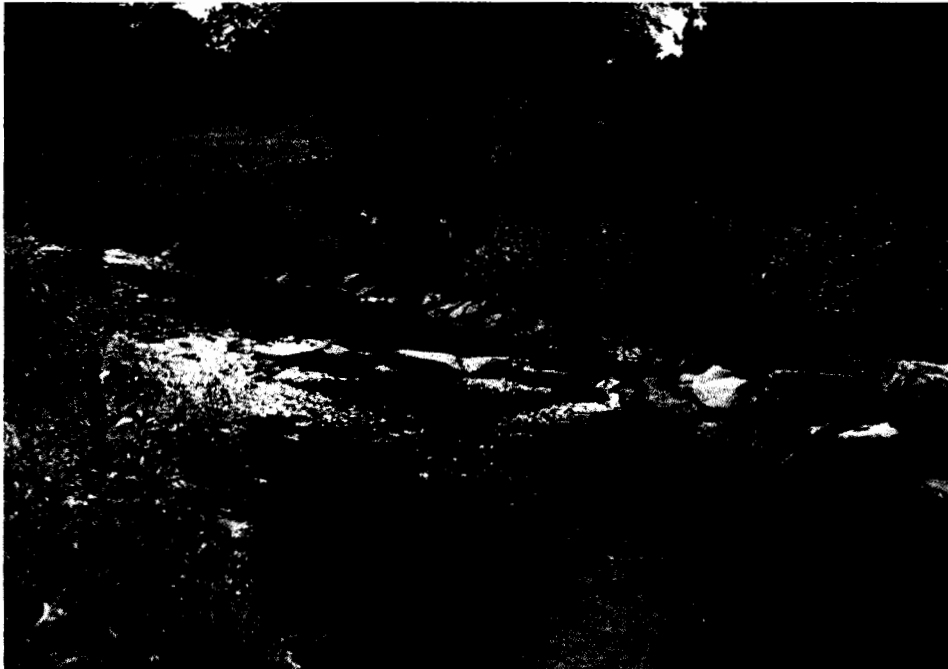
Photograph 3: View of the Wetland 2 basin from the path along Angelica Creek, facing east toward S.R. 0010. Note the monoculture stands of *Polygonum pensylvanicum* at the center of the basin (August 2008).



Photograph 4: View from the trail of the southern banks of Angelica Creek, facing east. This area is intended to be a riverine riparian zone (August 2008).



Photograph 5: View of the upland meadow adjacent to Wetland 1, along the gravel path leading to the boardwalk (August 2008).



Photograph 6: View of Rock Cross Vane #1 (RV1), from the southern banks of Angelica Creek, facing southwest (August 2008).



Photograph 7: View of Rock Cross Vane #2 (RV2), from the southern banks of Angelica Creek, facing northwest across the waterway (August 2008).



Photograph 8: View of Rock Cross Vane #3 (RV3), from the southern banks of Angelica Creek, facing southwest. This vane has significant erosion that may be affecting the hydrology of Wetland 1 (August 2008).



Photograph 9: View of Rock Cross Vane #4 (RV4) from the southern banks of Angelica Creek, facing northwest (August 2008).



Photograph 10: View of Rock Cross Vane #5 (RV5) from the southern banks of Angelica Creek, facing northwest toward the pedestrian bridge (September 2008).



Photograph 11: View of Rock Cross Vane #6 (RV6) from the southern banks of Angelica Creek, facing southeast toward the S.R. 0010 bridge (September 2008).

APPENDIX G:
SUPPLEMENTAL SITE
CONDITION PHOTOGRAPHS



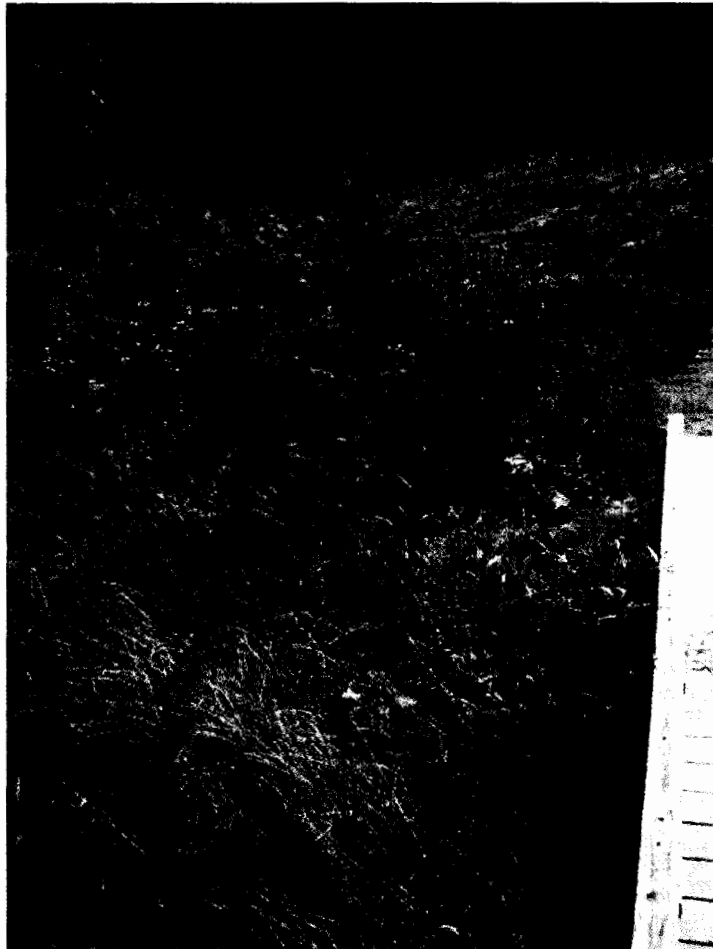
Photograph A: View of the riparian section near the pedestrian bridge, facing northwest. The invasive *Polygonum pensylvanicum* has grown as a monoculture, blocking out other vegetation and the view of the waterway (August 2008).



Photograph B: This is an example of a typical specimen of *Robinia pseudoacacia* at the site, after two years of growth. Its rapid growth crowds out other herbaceous and woody species, and its thorns and leaf litter are undesirable for a recreational facility (July 2008).



Photograph C: View of the pedestrian bridge from the southern banks of Angelica Creek. Erosion from the gravel construction entrance along the hillside is washing onto the banks, affecting the planted *Cornus amomum* shrubs. This entrance requires either removal or stabilization (August 2008).



Photograph D: View of the edge of the Wetland 1 basin from the boardwalk facing south toward the path. Gravel from the path is washing into the wetland, possibly affecting vegetative growth (August 2008).



Photograph E: Overview of the Angelica creek site, in the first winter after construction (February 2008).



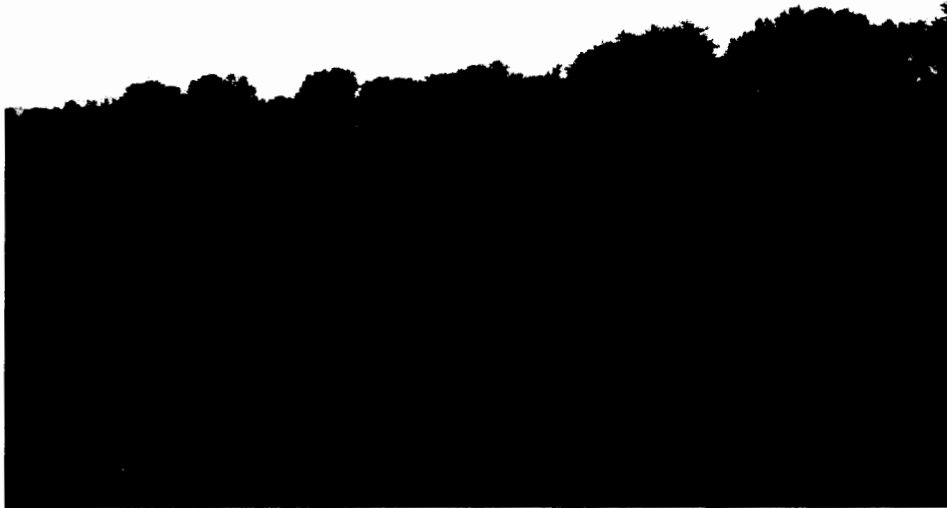
Photograph F: Overview of the Angelica Creek site, after the first full growing season (September 2008).



Photograph G: View of the Deep Pond at Wetland 1, from the outlet structure facing northwest (May 2008).



Photograph H: View of the deep pond at Wetland 1, near the outlet structure, facing southwest. A significant amount of vegetation now surrounds the pond (September 2008).



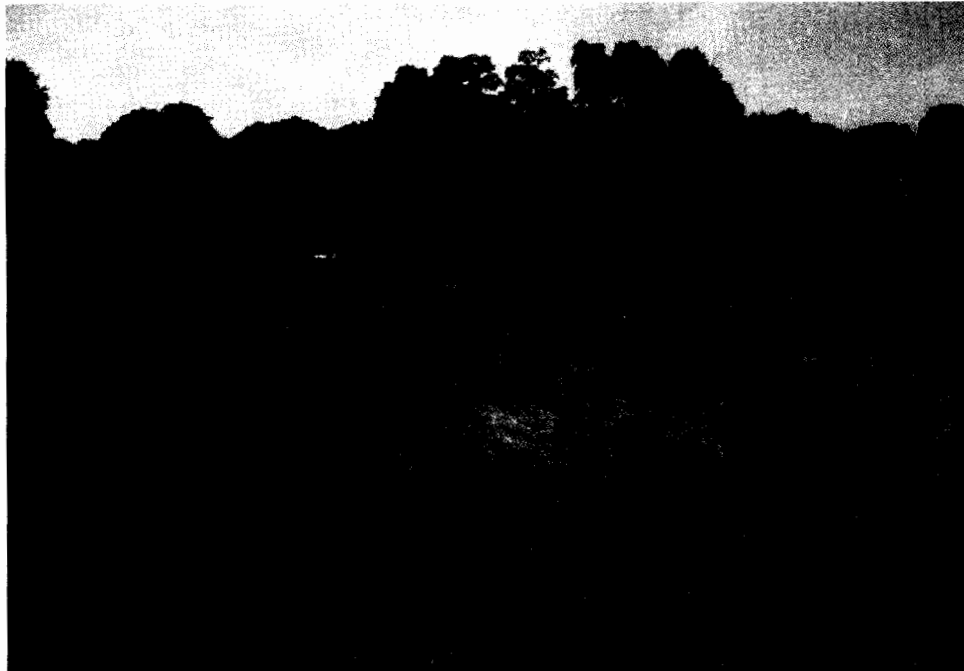
Photograph I: View of the meadow edge of Wetland 2, when the plains coreopsis was blooming (June 2008).



Photograph J: View of the meadow edge and Wetland 2 at the end of the first growing season. There is increased vegetative diversity at the site compared to June 2008 (September 2008).



Photograph K: View of Wetland 1, from the boardwalk facing west toward the cement bridge (May 2008).



Photograph L: View of Wetland 1, from the boardwalk facing west toward the cement bridge. Note the dead vegetation, indicating the lack of sufficient water at the center of the basin (September 2008).



Photograph M: View of the outlet structure of Wetland 1, from the western edge facing southeast. Note the water impounded by the stone wall (May 2008).



Photograph N: View of the outlet structure of Wetland 1, from the western edge facing southeast. The bare ground is caused by the ponded water present through part of the growing season (August 2008).



Photograph O: Overview of Wetland 2 and the surrounding meadow at the height of the growing season (July 2008).



Photograph P: View of the center of Wetland 2 during the spring after construction, facing toward the pedestrian bridge (May 2008).



Photograph Q: View of the center of Wetland 2 toward the end of the growing season, facing toward the waterway. This is the only area of Wetland 2 with ponded water (August 2008).



Photograph R: View downstream from the upper limit of the stream restoration corridor. The bridge is the existing pedestrian bridge to Alvernia College. (November 2008).



Photograph S: View downstream from the existing pedestrian bridge. Rock Cross Vane #3 is in the center. (November 2008).



Photograph T: View downstream of Rock Cross Vane #3 towards the section of Angelica Creek that has been undercut. Note that black willows have established on both sides of this area and have stabilized the banks. (November 2008).



Photograph U: View upstream towards the undercut area. This reach of Angelica creek contains stable banks and dense vegetation. Downstream of the photo location is the new pedestrian bridge. (November 2008).



Photograph V: View downstream from the new pedestrian bridge. Note the root was installed on the left bank and Rock Cross Vane #5 in the background. (November 2008).



Photograph W: View upstream from the Route 10 overpass. Rock Cross Vane #6 is in the center of the picture. (November 2008).

APPENDIX I:
CORRESPONDENCE AND
PERMIT DOCUMENTATION



Pennsylvania Department of Environmental Protection

909 Elmerton Avenue
Harrisburg, PA 17110-8200

AUG 18 2006

Southcentral Regional Office

717-705-4707
FAX - 717-705-4760

CERTIFIED MAIL NO. 7005 0390 0001 3161 2107

Charles M. Jones, P.E.
Public Works Director
503 North Sixth Street
Reading, PA 19601-3690

Re: Water Obstruction & Encroachment Permit
DEP File No. E06-610
APS ID No. 584491
Reading City, Berks County

Dear Mr. Jones:

Enclosed are duplicate copies of your Water Obstruction and Encroachment Permit. Please review the permit so that you are aware of the extent of authorization and conditions. **PLEASE SIGN BOTH COPIES OF THE WATER OBSTRUCTION & ENCROACHMENT PERMIT, RETURN THE FILE COPY TO THIS OFFICE WITHIN 15 DAYS AND KEEP THE OTHER COPY FOR YOUR RECORDS.** A self-addressed envelope is enclosed for your convenience. Please note that you do not have authorization to begin your project until DEP receives your signed copy of the Water Obstruction & Encroachment Permit. **IF YOU BEGIN WORK PRIOR TO DEP RECEIVING THE SIGNED COPY OF THE PERMIT, YOU ARE SUBJECT TO PENALTIES TOTALING UP TO \$10,000 PER DAY.** The Department will provide you with an acknowledgment letter upon receipt of the fully-signed permit.

Please be advised that you do not have federal authorization for this project and such authorization is required prior to starting your project. In accordance with procedures established with the U.S. Army Corps of Engineers, you will be contacted directly by the Corps regarding federal authorization.

Prior to the commencement of construction, the enclosed Acknowledgment of Appraisal of Permit Conditions must be completed and signed by you and an individual responsible for the supervision or conduct of the construction work acknowledging and accepting the general and special conditions contained in the permit. Unless the signed Acknowledgment of Appraisal of Permit Conditions is submitted to this office, the permit is void.

The Completion Report form must be signed by you and the supervising engineer indicating that the work has been completed as approved. The Completion Report must be submitted to this office within 30 days of the completion of the approved project.



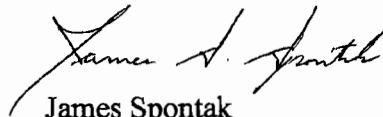
A copy of both the permit and the Acknowledgment of Appraisal of Permit Conditions must be available at the work site for inspection upon request by any officer or agent of DEP or any other federal, state, county and municipal agency.

Any person aggrieved by this action may appeal, pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. Section 7514, and the Administrative Agency Law, 2 Pa. C.S. Chapter 5A, to the Environmental Hearing Board, Second Floor, Rachel Carson State Office Building, 400 Market Street, PO Box 8457, Harrisburg, PA 17105-8457, 717-787-3483. TDD users may contact the Board through the Pennsylvania Relay Service, 800-654-5984. Appeals must be filed with the Environmental Hearing Board within 30 days of receipt of written notice of this action unless the appropriate statute provides a different time period. Copies of the appeal form and the Board's rules of practice and procedure may be obtained from the Board. The appeal form and the Board's rules of practice and procedure are also available in braille or on audiotape from the Secretary to the Board at 717-787-3483. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST REACH THE BOARD WITHIN 30 DAYS. YOU DO NOT NEED A LAWYER TO FILE AN APPEAL WITH THE BOARD.

IMPORTANT LEGAL RIGHTS ARE AT STAKE, HOWEVER, SO YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD (717-787-3483) FOR MORE INFORMATION.

Sincerely,



James Spontak
Program Manager
Watershed Management Program

Enclosures

cc: Mike Campbell, A. D. Marble & Co.

Commonwealth of Pennsylvania
Department of Environmental Protection
Southcentral Regional Office
Watershed Management Program
Permitting and Technical Services Section

CHAPTER 106. FLOODPLAIN MANAGEMENT

The Department of Environmental Protection "DEP", established by the Act of December 3, 1970, P.L. 834 (71 P.S. §§ 510-1 et seq.) and empowered to exercise certain powers and perform certain duties under and by virtue of the Act of November 26, 1978, P.L. 1375, as amended by the Act of October 23, 1979, P.L. 204 (32 P.S. §§ 693.1 et seq.) known as the "Dam Safety and Encroachments Act"; Act of October 4, 1978, P.L. 851, (32 P.S. §§ 679.101 et seq.) known as the "Flood Plain Management Act"; Act of June 22, 1937, P.L. 1987, (35 P.S. §§ 691.1 et seq.), known as "The Clean Streams Law"; and the Administrative Code, Act of April 9, 1929, P.L. 177, as amended, which empowers DEP to exercise certain powers and perform certain duties by law vested in and imposed upon the Water Supply Commission of Pennsylvania and the Water and Power Resources Board, hereby issues this permit to:

Charles M. Jones, P.E.
Public Works Director
503 North Sixth Street
Reading, PA 19601-3690

giving his consent to restore and maintain 1,600 linear feet of Angelica Creek (CWF), realign and maintain 400 feet of Angelica Creek (CWF), construct and maintain six cross rock vanes, five root wad structures, and four log vanes in Angelica Creek (CWF), two 1.0-acre wetlands, 0.5-acre pond, extend and maintain an existing 42-inch PSPP stormwater outfall 70-feet along Angelica Creek (CWF), and construct and maintain two temporary road crossings each consisting five, 40.0-foot long, 42-inch pipes in Angelica Creek (CWF), and a pedestrian bridge having a width of 5.0 feet, a normal span of 58.0, feet and an under clearance of 8.0 feet across Angelica Creek (CWF). The project includes the restoration of the riparian buffer along both sides of Angelica Creek (CWF) through planting of various native herbaceous plants, shrubs, and trees. The project is at the former location of Angelica Lake, just west of the new Route 10 bridge, south of the Schuylkill River (Reading, PA Quadrangle, upstream limit: N: 10.8 inches; W: 7.78 inches; Latitude: 40°18'34", Longitude: 75°55'51"; downstream limit: N: 11.10 inches; W: 6.85 inches; Latitude: 40°18'40", Longitude: 75°55'27") in the City of Reading, Berks County.

The issuance of this permit also constitutes approval of a Water Quality Certification under Section 401 of the Federal Water Pollution Control Act [33 U.S.C.A. 1341(a)].

This permit is issued in response to an application filed with DEP on the 18 day of May A.D. 2006, and with the understanding that the work shall be performed in accordance with the maps, plans, profiles and specifications filed with and made a part of the application on the 18th day of May A.D. 2006 subject, however, to the provisions of the Dam Safety and Encroachments Act, the Flood Plain Management Act, The Clean Streams Law, the Administrative Code, the rules and regulations promulgated thereunder and the following conditions and restrictions. If the work authorized by this permit is not completed on or before the 31st day of December A.D. 2009 this permit, if not previously revoked or specifically extended by DEP in writing, shall become void without further notification.

1. The permittee shall sign the permit thereby expressly certifying the permittee's acceptance of, and agreement to comply with, the terms and conditions of the permit. The permittee shall return a signed copy of the permit to DEP. The permit will not be effective until the signed copy of the permit is received by DEP;
2. DEP, in issuing this permit, has relied on the information and data which the permittee has provided in connection with his permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete or inaccurate, this permit may be modified, suspended, or revoked, in whole or in part, and DEP may, in addition, institute appropriate legal proceedings;
3. This permit does not give any property rights, either in real estate or material, nor any exclusive privileges, nor shall it be construed to grant or confer any right, title, easement, or interest in, to, or over any land belonging to the Commonwealth of Pennsylvania "Commonwealth"; neither does it authorize any injury to private property or invasion of private rights, nor any infringement of federal, state, or local laws or regulations; nor does it obviate the necessity of obtaining federal assent when necessary;
4. The work shall at all times be subject to supervision and inspection by representatives of DEP, and no changes in the maps, plans, profiles, and specifications as approved shall be made except with the written consent of DEP. DEP, however, reserves the right to require such changes or modifications in the maps, plans, profiles, and specifications as may be considered necessary to assure compliance with the Dam Safety and Encroachments Act and other laws administered by DEP, the Pennsylvania Fish Commission and any river basin commission created by interstate compact. DEP further reserves the right to suspend or revoke this permit for failure to comply with a provision of 25 Pa. Code Chapter 105, an administrative order of DEP or a term or condition of this permit;
5. This permit authorizes the construction, operation, maintenance and normal repair of the permitted structures conducted within the original specifications for the water obstruction or encroachment, and in accordance with the regulations of DEP and terms and conditions of this permit. Any repairs or maintenance involving modifications of the water obstruction or encroachment from its original specifications, and any repairs or reconstruction involving a substantial portion of the structure as defined by regulations of DEP shall require the prior written approval and permit of DEP;
6. All construction debris, excavated material, brush, rocks, and refuse incidental to this work shall be removed entirely from the stream channel and placed either on shore above the influence of flood waters, or at such dumping ground as may be approved by DEP;
7. There shall be no unreasonable interference with the free discharge of the river or stream or navigation during construction;
8. DEP reserves the right to take any and all actions regarding the permitted activity that are authorized by law to protect public health, public safety and the environment;

Permit No. E06-610

9. The permittee shall notify DEP, in writing, of the proposed time for commencement of work at least 15 days prior to the commencement of construction;
10. If construction work has not been completed within the time specified in the permit and the time limit specified in the permit has not been extended in writing by DEP or if a permit has been revoked for any reason, the permittee shall, at his own expense and in a manner that DEP may prescribe, remove all or any portion of the work as DEP requires and restore the water course and floodplain to their former condition;
11. The permittee shall fully inform the engineer or contractor, responsible for the supervision and conduct of work, of the terms, conditions, restrictions and covenants of this permit. Prior to the commencement of construction, the permittee shall file with DEP in writing, on a form provided by DEP, a statement signed by the permittee and an individual responsible for the supervision or conduct of the construction work acknowledging and accepting the general and special conditions contained in the permit. Unless the acknowledgment and acceptance have been filed, the permit is void. A copy of the permit and the acknowledgment shall be available at the work site for inspection upon request by an officer or agent of DEP or another federal, state, county or municipal agency;
12. The permittee shall operate and maintain the structure or work authorized herein in a safe condition in accordance with the permit terms and conditions and the approved maps, plans, profiles and specifications;
13. This permit may not be transferred without prior written approval from DEP, such approval being considered upon receipt of the properly executed "Application for Transfer of Permit" form;
14. If and when the permittee desires to discontinue use or abandon the activity authorized herein, he must remove all or part of the structure or work authorized and take other actions as are necessary to protect safety and the environment in accordance with a permit issued by DEP;
15. If the use of explosives in any waterways is required, the permittee shall secure the prior written permit from the Pennsylvania Fish and Boat Commission, pursuant to the Pennsylvania Fish and Boat Code, Act 1980-175 Title 30 Pennsylvania Consolidated Statutes, Section 2906. Requests should be directed to the Pennsylvania Fish and Boat Commission, Bureau of Administrative Services, PO Box 67000, Harrisburg, PA 17106; telephone 717-705-7900;
16. Permittee shall implement and monitor the Erosion and Sedimentation Control Plan prepared in accordance with Chapter 102 so as to minimize erosion and prevent excessive sedimentation into the receiving watercourse or body of water;
17. The project site shall at all times be available for inspection by authorized officers and employees of the Pennsylvania Fish and Boat Commission. Prior to commencement and upon completion of the work authorized by this permit, the permittee shall notify the

Pennsylvania Fish and Boat Commission's Southeast Regional Office, Box 8, Elm, PA 17521; telephone 717-626-0228;

18. The project site shall at all times be available for inspection by authorized officers and employees of the Berks County Conservation District. Prior to commencement and upon completion of the work authorized by this permit, the permittee shall notify the Berks County Conservation District, PO Box 520, 1238 County Welfare Road, Leesport, PA 19533; telephone 610-372-4657.

19. **SPECIAL CONDITIONS**

- a. Angelica Creek is managed as a wild trout fishery. No work shall be done in the stream channel between October 1 and December 31 without the prior written approval of the Pennsylvania Fish and Boat Commission's Division of Environmental Services, 450 Robinson Lane, Bellefonte, PA 16823-9620; telephone 814-359-5147.
- b. Permittee shall monitor the wetland replacement site for at least five years. Reports shall be submitted to DEP every six months for the first two years after construction and annually for three years thereafter. The monitoring reports shall contain information describing the success of the site at the time of inspection, an inventory of the surviving plant species and percent aerial coverage, invasive species, photographs of the replacement site with plans showing the location and orientation of each of the photographs, and a written plan to correct any deficiencies identified during the monitoring phase.
- c. Permittee shall monitor the restored stream for at least five years. Reports shall be submitted to DEP every year after construction. The reports shall contain information describing the success of the site at the time of inspection, stability of the banks, photographs of the stream with plans showing location and orientation of the photographs, an inventory of surviving plantings, and a written plan to correct any deficiencies identified during the monitoring.
- d. Permittee shall maintain the structure(s) herein authorized free of flood debris and silt deposits. When removal of silt and debris is necessary, it shall be accomplished in accordance with DEP's "Standards for Channel Cleaning at Bridges and Culverts," a copy of which is attached and made part of this permit.

Future bridge and culvert rehabilitation and maintenance work is subject to the following conditions:

- (1) No reduction of span, underclearance or waterway opening of the structure will occur.
- (2) No roadway grade will be altered, other than that required for normal resurfacing.
- (3) No substantial modification of the structure from its original specifications will be permitted.


- (4) When work involves repairs to piers, footers or wingwalls, the construction area should be enclosed wherever possible within a cofferdam of sandbags or other nonpollution material.
- (5) The placement of riprap, where necessary, shall not constrict the normal channel width nor shall it interfere with any navigation on the stream or migration of fish.
- e. Temporary stream crossing(s) shall be constructed of suitable non-erodible material in order to prevent any road materials from washing out if structure is overtopped during periods of high water.
- f. The temporary road crossings shall be removed in their entirety upon completion of the project and the channel properly restored and stabilized.

Permittee hereby accepts and agrees to comply with the terms and conditions of this permit.

Permittee (signature)

Date

DEPARTMENT OF ENVIRONMENTAL PROTECTION



James S. Spontak
Program Manager

AUG 18 2006

Issue Date

Permit Application Review Process Fact Sheet
Department of Environmental Protection (DEP)
Southcentral Region

PERMIT PROCESS INFORMATION

Permit Coordination:

Your permit application will be sent to other regulatory programs within DEP for a preliminary review to determine if other permits are required for the activity you are proposing. If it appears other permits are necessary, you will be sent applications for those regulated activities. The coordination of the permit application reviews will be the responsibility of the Assistant Regional Director, Lynn Langer, who can be reached at 717-705-4929.

Administrative Reviews:

Administrative reviews vary slightly by program, but generally include checking for the appropriate signatures, filing fees, notarizations, maps, and application forms. The purpose of the administrative completeness review is to determine whether information and forms are provided. It is not to evaluate the quality or content of the information. Administrative reviews are generally conducted within 20 days of the receipt of the application.

If your application is administratively deficient, we will notify you by phone or letter. You will be given a reasonable time frame in which to submit the required information. If the information is not submitted within that time frame, the application will be returned to you without action by DEP.

When an application is determined to be administratively complete, it will be accepted for technical review by DEP. This means that DEP will initiate the technical review of the application. You will be notified by letter that your application has been accepted. At that time, you will be given the name and phone number of the person to whom your application has been referred for review.

Technical Reviews:

Technical reviews begin once an application is deemed administratively complete and are performed by one or more of DEP's professional staff. The technical review includes an analysis of the proposal for potential adverse environmental impacts; the completeness, clarity and soundness of engineering proposals; conformance with applicable statutes and regulations; and analysis of comments submitted by the public. Please note, applications containing major technical errors will not be reviewed by the agency. Rather, they will be returned with a request that the applicant take more care in preparing the application.

A critical part of the technical review process is the review of comments from the general public and other governmental agencies. Comments may be solicited as a result of publishing a notice of the permit request for draft permit in the *Pennsylvania Bulletin* and newspapers of general circulation, circulating the application to other governmental agencies, or through public meetings or hearings. Unsolicited comments in the form of letters and petitions are also given consideration.

DEP staff will review the application and all other relevant information, and you will be notified by phone or letter if there are deficiencies in your application. You will be given a reasonable period of time in which to address the deficiencies. If you fail to do so within the allotted time, your application will be denied. If the material you submit in response to the deficiency letter still fails to meet DEP's requirements, you will be issued a pre-denial letter. This letter will state that DEP is prepared to deny your application if the ongoing deficiencies are not corrected within a stated time frame. You will have one final opportunity to address those deficiencies; otherwise, the permit will be denied.

When DEP has completed the technical review of your application, a decision will be rendered. If all applicable requirements are met, your permit will be issued. If multiple permits are involved, they will be issued simultaneously from the Assistant Regional Director's office. Permits may be denied for a number of reasons including failure to supply the required information needed for a complete and comprehensive technical review (as described in the paragraph above); failure to show that the activity will not have an adverse impact on the environment; failure to satisfy all applicable legal requirements; or, in some cases, a negative compliance history of the applicant.

If you believe the stated deficiencies in either the deficiency letter or pre-denial letter are not significant, you have the option of declining and asking DEP to make a decision based on the information you have already made available.

Public Input and Participation:

Permit applications may be subject to any or all of the following: notice in the *Pennsylvania Bulletin* or other publication of general circulation; a public meeting; a public hearing. These opportunities for public input are often required by regulation or statute, but may also occur at the discretion of DEP.

Appeal Process:

Any person aggrieved by this action may appeal, pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. Section 7514, and the Administrative Agency Law, 2 Pa. C.S. Chapter 5A, to the Environmental Hearing Board, Second Floor, Rachel Carson State Office Building, 400 Market Street, PO Box 8457, Harrisburg, PA 17105-8457, 717-787-3483. TDD users may contact the Board through the Pennsylvania Relay Service, 800-654-5984. Appeals must be filed with the Environmental Hearing Board within 30 days of receipt of written notice of this action unless the appropriate statute provides a different time period. Copies of the appeal form and the Board's rules of practice and procedure may be obtained from the Board. The appeal form and the Board's rules of practice and procedure are also available in braille or on audiotape from the Secretary to the Board at 717-787-3483. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

We hope you find this information helpful in understanding the application review process.



A. D. MARBLE & COMPANY

Environmental Planning &
Studies

375 East Elm Street
Suite 200
Conshohocken, PA 19428
Telephone: (484) 533-2500
Fax: (484) 533-2599

To: Pennsylvania Department of Environmental Protection
South Central Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110
Att: Mr. Dan Welte

RE: Request for clarification on the size of the proposed pond at Angelica Park

Mr. Welte,

Please be advised that there was an error in Section G – Project Description and Plan Narrative of our JPA application for Angelica Park Improvements submitted in June of 2006. The first sentence of the second paragraph of the General Design Concepts section should read as follows:

This overall design includes the creation of approximately two acres of wetland creation, the creation of a 0.5 acre recreation pond, and the enhancement of the floodplain.

Please note that this is stated correctly in paragraph 5 of this section. Please contact me if you need further clarification on this matter.

Sincerely,

Michael J. Campbell
Project Manager/ Associate Landscape Architect
A.D. Marble & Company
484-533-2547
Campbell@admarble.com



Pennsylvania Department of Environmental Protection

909 Elmerton Avenue
Harrisburg, PA 17110-8200
July 20, 2006

Southcentral Regional Office

717-705-4707
FAX - 717-705-4760

Charles M. Jones, P.E.
City of Reading
503 North Sixth Street
Reading, PA 19601

Re: Administrative Complete Letter
Angelica Park/Creek Restoration
Application No. E06-610
Reading City, Berks County

Dear Mr. Jones:

On July 17, 2006, the Department of Environmental Protection (DEP) received the approved Erosion and Sediment Control Plan from the Berks County Conservation District for the Angelica Park restoration project. We have determined that the application now contains the necessary documents and is administratively complete.

The administrative completeness review is the first in a series of reviews conducted by DEP. To help you better understand the application review process, a brief explanation of the permit application review process and approximate times are outlined on the enclosed Permit Application Review Process Fact Sheet.

Your application has been forwarded to the Army Corps of Engineers for review.

I hope you find this information helpful in understanding the application review process. If you have additional questions about your application, please call me at 717-705-4746 and refer to Application No. E06-610.

Sincerely,

Dan Welte
Permitting and Technical Services Section
Watershed Management Program

Enclosure (MBG005)

cc: Mike Campbell, A.D. Marble & Company
Brenda Schrecengost, US Army Corps of Engineers, Philadelphia District Office



DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

SEP 10 2006

Regulatory Branch
Application Section I

SUBJECT: CENAP-OP-R-200601059-61 (PASPGP-3)
PADEP #:E06-610

Charles Jones, P.E.
Public Works Director
City of Reading
815 Washington Street
Reading, Pennsylvania 19601-3615

Dear Mr. Jones:

Reference is made to your application to restore the twelve acre drained lake bed adjacent to Angelica Creek, west of the S.R. 10 bridge, at Angelica Lake Park in the City of Reading, Berks County, Pennsylvania.

You are hereby authorized by the U.S. Army Corps of Engineers to conduct the above referenced work under the authority of the enclosed Pennsylvania State Programmatic General Permit (PASPGP-3) (Enclosure 1). Please note that you must conduct the authorized work in accordance with the requirements and conditions of the PASPGP-3 and the following special conditions:

Special Conditions:

1. All work performed in association with the above noted project shall be conducted in accordance with the project plans identified as "Angelica Park Joint Permit Application," sheets 1-13 of 13, dated May 2006, as prepared by A.D. Marble & Company. The project plans provide for approximately 1600 linear feet of stream restoration, 400 linear feet of stream relocation, and creation of a riparian buffer, two 1 acre wetlands, and one 0.5 acre pond. The stream restoration will involve the use of PA Fish and Boat Commission approved trout habitat enhancement structures, including 4 log vanes, 6 rock cross vanes, and 5 root wad structures. The design also includes overflow control structures to allow high flow to be dispersed into the floodplain and the newly-created wetland systems. The existing 42-inch PSPP stormwater outfall will be extended and two temporary road crossings, each consisting of five 40-foot long 42" pipes, will be installed in Angelica Creek. The stated purpose of the project is to provide for stream and wetland restoration.

2. Any deviation in construction methodology or project design from that shown on the above noted drawings must be approved by

this office, in writing, prior to performance of the work. All modifications to the above noted project plans shall be approved, in writing, by this office. No work shall be performed prior to written approval of this office.

3. This office shall be notified within 10 days of the completion of the authorized work by completing and signing the enclosed "PASPGP-3 PERMIT COMPLIANCE, SELF CERTIFICATION FORM" (Enclosure 2). All notifications required by this condition shall be in writing and shall be transmitted to this office by registered mail. Oral notifications are not acceptable. Similar notification is required each time maintenance work is to be done under the terms of this Corps of Engineers permit.

4. Appropriate erosion and sedimentation control measures must be used and maintained in effective operating condition during construction, and all exposed soil and other fills must be permanently stabilized at the earliest practicable date.

5. The two temporary road crossings shall be removed upon completion of the project, and no later than 30 days from the date of project completion.

If you should have any questions regarding this matter, please contact Brenda R. Schrecengost of this office at (215) 656-5866 between the hours of 1:00 and 3:30 p.m. or write to the above address.

Sincerely,

Frank J. Cianfrani
Chief, Regulatory Branch

Enclosures

Copies Furnished:

PADEP SCRO
Berks Count Conservation District

✓A.D. Marble & Company
375 East Elm Street
Conshohocken, PA 19428

Christopher A. Day (3RC20)
U.S. EPA - Region III
1650 Arch Street
Philadelphia, PA 19103-2029; and

Margaret L. Hutchinson
Assistant United States Attorney
Civil Division Eastern District of Pennsylvania
615 Chestnut Street, Suite 1250
Philadelphia, PA 19106-4476
Re: USAO No. 2003V00437

The transmittal letter forwarding such notice shall include the caption, civil action number and judicial district of this action.

50. Payments to the Commonwealth of Pennsylvania shall be made by tendering to the Pennsylvania Department of Environmental Protection checks made payable to: "Commonwealth of Pennsylvania Clean Water Fund," and sent to Pennsylvania Department of Environmental Protection, 909 Elmerton Ave., Harrisburg, PA 17110-8200, Attn: Lee Yohn, Compliance Specialist.

51. If Defendant fails to tender all or any portion of the civil penalty payment owed to the United States within thirty (30) days of the Date of Entry of this Consent Decree interest on the unpaid amount shall accrue in accordance with the provisions of 28 U.S.C. § 1961 and be paid from the date said payment is due until all amounts owed are paid.

X. SUPPLEMENTAL ENVIRONMENTAL PROJECTS: Angelica Stream Restoration

52. Defendant shall implement Supplemental Environmental Projects ("SEP") in accordance with all provisions set forth in this Consent Decree. The SEPs will consist of the projects as further described in Subparagraphs 52 (a) through 52 (i) below to restore Angelica Creek from Angelica Park to the Schuylkill River, to remove excess sediment, and to create several riparian buffers, functional wetlands and flood plain meadows as well as provide for maintenance. The SEP restoration projects shall be completed within two years of the Entry Date with an additional five years for monitoring and maintenance.

(a) **Background:** Prior to 2001, Angelica Creek meandered through Angelica Park located in the City of Reading, and emptied into Angelica Lake where it was contained by a dam at Route 10. The Lake and Creek were used frequently by the community for recreational purposes for fishing and boating. Both the Lake and Creek are designated as trout stocking waters and supported a diverse aquatic community including trout. In 2001 the Dam was breached and the lake was emptied leaving behind a great deal of sediment and impaired aquatic life conditions. Since that time, the stream has begun forming a natural meandering channel through the lake bed sediments and continues on beneath the newly built bridge at Route 10. The stream through that is heavily degraded and down cutting the lake bed sediment layer due to a lack of vegetation and bank stabilization. A large amount of sediment is being deposited into the stream and contributing to high sediment loads entering the Schuylkill River. The City of Reading has decided not to rebuild the dam.

(b) **Goals of SEPs:** The goals of these SEPs are to restore the recreational and aquatic life uses of Angelica Creek from Angelica Park to the Schuylkill River by removing excess lake bed sediment, restoring the Creek, creating two wetlands and a flowering meadow flood plain. These SEPs are intended to restore the recreational and aquatic life uses of Angelica Creek, they will also substantially reduce the sediment load to the Schuylkill River. These SEPs are consistent with and will further achieving the goals of the Clean Water Act. In addition to the SEPs described below, the City of Reading is also planning to make a number of enhancements to the park including a pedestrian bridge, park benches, and signage to provide information about the Creek, the SEPs and the surrounding ecosystems.

(c) **Removal of excess sediment and soil stabilization SEP:** Within fifteen (15) months of the Entry Date, the Defendant shall remove excess sediments from the Areas marked on the Map attached to this Decree as Exhibit A and stabilize existing soils as necessary to complete the other projects described below. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items information on the depth

of sediment and area for this project sufficient to calculate the cubic yards of sediment to be removed from the Area. Defendant estimates expenditure for this SEP at \$300,000.

(d) Angelica Creek Restoration SEP: Within two years of the Entry Date, Defendant shall complete approximately 1600 linear feet (LF) of stream restoration from the pedestrian bridge in Angelica Park to the Route 10 bridge underpass as indicated on the Exhibit A to the Decree. Defendant shall also restore an additional 400 LF of degraded stream restoration below the Route 10 Bridge to the Schuylkill River. The Stream banks will be graded, stabilized with rock protection and multiple bio-engineering techniques such as erosion control matting and appropriate stream bank plantings. In order to control the flow of stream, multiple structures including constructed riffles, rock deflectors and root wads will be placed along the length of the stream. These structures will contribute to the stabilization of the stream channel reducing the possibility of sediment erosion as well as increase aquatic habitat. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items the specific plant species to be used, the density of plantings and where the plants will be used. Defendant shall not spend less than \$93,000 for this SEP.

(e) Angelica Creek Riparian Buffer SEP: Within two years of the Entry Date, Defendant shall complete a minimum one hundred foot (100') riparian buffer strip for Angelica Creek (with at least fifty feet of riparian buffer on each side of the Creek) from the pedestrian bridge in Angelica Park to the Route 10 underpass. This SEP will filter runoff, slowing flow of storm water, reducing erosion and will provide shade coverage for the stream channel. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items the specific plant species to be used, the density of plantings and where the plants will be used. Defendant shall not spend less than \$54,000 on this SEP.

(f) Wetland Creation SEP: Within two years from the Entry Date, Defendant shall complete construction and planting for two wetlands adjacent to Angelica Creek in the approximate locations as indicated on Exhibit A to this Decree. Each wetland shall be

approximately 1 acre in size. These two wetlands will provide relief for the stream during storm events, reduce erosion and contribute to treatment of water quality. To enhance the contribution of this SEP to aquatic and wildlife uses, each wetland will provide several types of wetland habitat and will include wildlife structures such as brush piles and deadfall snags. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items details of the elevations and area of the proposed wetland, the specific plant species to be used, the density of plantings and where the plants will be used. Defendant shall not spend less than \$69,000 on this SEP.

(g) Flood plain Meadow SEP: Within two years of the Entry Date, Defendant shall create approximately three (3) acres of flood plain meadow in the general areas adjacent to the wetlands and Angelica Creek as indicated on Exhibit A to this Decree. Design and construction of these meadows shall be incorporated into the design and creation of the wetlands described above in Subparagraph (f). These meadows will contribute to relief for the stream during storm events, reduce erosion as well as increase the diversity of wildlife habitat and contribute to park aesthetics. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items the specific plant species to be used, the density of plantings and where the plants will be used. Defendant shall not spend less than \$10,000 on this SEP.

(h) Annual Maintenance and Access to SEPs: Defendant shall provide adequate maintenance including replacement of necessary plantings for the SEPs discussed above in Subparagraphs 52 (d) through 52 (g) for no less than five years after EPA approves the completion of each SEP. In order to provide adequate maintenance for the SEPs described above, reduce the threat of invasive species and to facilitate public access to the Angelica Creek, Defendant shall also construct a crushed stone walking trail and adequate landscaping to reduce erosion from that trail and public access. Defendant is encouraged to connect this trail with existing Park trails. Defendant shall spend not less than \$32,000 in construction costs for the

trail and associated landscaping. As part of the SEP final plan submission described in Subsection 52 (i) below, Defendant shall identify among other items the specific plant species to be used, the density of plantings and where the plants will be used, and how the associated landscaping and maintenance will prevent the introduction and spread of invasive species. Defendant shall spend no less than \$5,000 per year for each year of maintenance of the SEPs identified above in Subparagraphs 52 (d) through 52 (g).

(i) Design Costs and Final Plan

Defendant shall provide adequate design and obtain necessary permits and approval for each of the SEPs described above. Defendant estimates that design costs will be no less than \$150,000. Within seven (7) months of the Entry Date, Defendant shall submit a final plan to EPA and PADEP for review. This final plan shall include the details of design and completion for each SEP as discussed above in Subparagraphs 52 (c) through 52 (g). Upon approval by EPA in accordance with Paragraph 43 of this Decree, Defendant shall then proceed to implement each SEP according to the schedule contained in each Subparagraph of this Decree.

(j) Defendant Certification: With regard to the SEPs, Defendant certifies the truth and accuracy of each of the following:

1. That all cost information provided to EPA and PADEP in connection with EPA's approval of the SEP is complete and accurate and represents a fair estimate of the costs necessary to implement the SEP;
2. That, as of the date of lodging of this Decree, Defendant is not required to perform or develop the SEP by any federal, Commonwealth, or local law or regulation, or as injunctive relief awarded in any other action in any forum;
3. That Defendant has not received, and is not negotiating to receive, credit for the SEP in any other enforcement action; and
4. That Defendant will not receive any reimbursement for any portion of the SEP from any other person.

(k) SEP Completion Report

1. Within 90 days after the date set for completion of each SEP described above in subparagraphs 52 (c) through 52 (g), Defendant shall submit a SEP Completion Report to EPA and PADEP. If appropriate, the Report may combine information on the completion of more than one SEP. The SEP Completion Report shall contain the following information:

- a) A detailed description of the SEP as implemented;
- b) A description of any problems encountered in completing the SEP and the solutions thereto;
- c) An itemized list of all eligible SEP costs;
- d) Certification that the SEP has been fully implemented pursuant to the provisions of this Decree; and
- e) A description of the environmental and public benefits resulting from implementation of the SEP (with a quantification of the benefits and pollutant reductions, if feasible).

2. EPA may, in its sole discretion, require information in addition to that described in the preceding Paragraph, in order to determine the adequacy of SEP completion or eligibility of SEP costs.

3. After receiving the SEP Completion Report, EPA shall notify Defendant whether or not Defendant has satisfactorily completed the SEP. If the SEP has not been satisfactorily completed in accordance with all schedules, or if the amount expended on performance of each SEP is less than the 90% of amount set forth above, stipulated penalties may be assessed in accordance with Paragraph 55 of this Consent Decree.

4. Disputes concerning the satisfactory performance of the SEP and the amount of eligible SEP costs may be resolved under Section XIII of this Decree (Dispute Resolution). No other disputes arising under this Section shall be subject to Dispute Resolution.

5. Each submission required under this Section shall be signed by an